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ASFA

PROGRESS REPORT ON RESEARCH AND RELATED SERVICES  
APPLICABLE TO  
DAIRY

Including Work in United States Department of Agriculture  
and Certain State Work Financed in Part with  
Agricultural Marketing Act Funds

\* \* \*

Prepared for Use in Connection with the  
December 1958 Meeting of the  
Dairy Research and Marketing Advisory Committee

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This progress report is a "tool" for: (1) administrative use in program development, coordination and evaluation; (2) advisory committee use in formulation of recommendations in regard to present and future programs. The material in the report is not for publication. Included are many tentative or indicated findings that have not been sufficiently tested for public release. As soon as these results are ready for release, the information will be released promptly through established channels. The report also includes research findings that have already been released. The publications containing the public release are cited. Public reference to the findings that have been released should mention the publication in which the release was made, NOT this progress report.

For the reasons given, copies of this report are available only to research administrators and workers directly concerned with the development and conduct of the program and to advisory committee members. Those receiving it are asked to observe strictly the limitation: "Administratively Confidential -- Not to be quoted or copied."

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UNITED STATES DEPARTMENT OF AGRICULTURE  
Washington, D. C.  
November 1958

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## FUNCTIONS OF ADVISORY COMMITTEES

Functions of the advisory committeemen include:

1. Acquainting themselves with the problems of producers, processors, distributors, and consumers, and presenting them for committee consideration.
2. Reviewing the current research and marketing service programs of the Department and recommending adjustments, including terminations, in the current program in order that available funds, personnel and facilities will be used on problems of greatest importance.
3. Recommending new work or expansion of current work and indicating relative priority of such recommendations, when the current program is insufficient to develop solutions for important problems.
4. Developing a better understanding of the nature and value of the the agricultural research program, explaining it to interested groups and organizations and encouraging the wider and more rapid application of the findings of research.

The committees can perform an important function in advising with respect to the development of the Department's research and marketing service programs. However, committee members should recognize that the development of budgets and the implementation and administration of research and marketing programs are responsibilities of the Department.

## COOPERATION

Much of the research on dairy covered in this report is conducted in cooperation between agencies of the United States Department of Agriculture and the State agricultural experiment stations. The studies find their origin in problems of producers, processors, distributors and consumers, and representatives of these groups frequently participate in the cooperation. Cooperative programs are jointly planned and conducted in a manner to make full use of the personnel and resources of each participating group with the minimum of duplicative effort. The results of cooperative research are jointly prepared in the form of uniform recommendations.



## CRITERIA FOR EVALUATION OF RESEARCH NEEDS

In discharging the function of advising the Department on agricultural problems and their relative importance, advisory committees should consider the following criteria in evaluating proposed new or expanded work:

1. Scope or size of problem ..... Local, Regional, National  
Number of acres, farms, firms, volume  
of product, dollars, etc., involved
2. Character of research ..... Basic or applied  
Extent of contribution to present  
program and problems  
Time and manpower required
3. Probable uses or adoption  
of results by ..... Producers, consumers, or industries  
affected  
Public bodies  
Research workers
4. Urgency or seriousness ..... Health or welfare  
National security  
Economic
5. Contributory factors ..... Cooperation of States and industries  
affected  
Availability of special funds,  
facilities, materials, personnel

It is recognized that in the formation of an adequate, dynamic, balanced, and well-coordinated program of research, other factors, in addition to the importance of the problem, must be taken into consideration by those responsible for initiation and prosecution of the program. Questions dealing with how, where, by whom, and at what cost the research shall be done are the responsibilities and functions of the scientists and research administrators.

It is the responsibility of the Department to assemble the detailed information that a committee needs to apply the criteria for "Evaluation of Research Needs."





SYMBOLS USED TO DESIGNATE REPORTING AGENCIES

ARS - Agricultural Research Service

- AE - Agricultural Engineering Research Division
- ADP - Animal Disease and Parasite Research Division
- AH - Animal Husbandry Research Division
- CR - Crops Research Division
- ENT - Entomology Research Division
- EU - Eastern Utilization Research and Development Division
- FE - Farm Economics Research Division
- HHE - Household Economics Research Division
- HN - Human Nutrition Research Division
- SWC - Soil and Water Conservation Research Division
- WU - Western Utilization Research and Development Division

AMS - Agricultural Marketing Service

- AEC - Agricultural Economics Division
- AEs - Agricultural Estimates Division
- MRD - Market Research Division
  - BS - Biological Sciences Branch
  - MD - Market Development Branch
  - OC - Market Organization and Costs Branch
  - TF - Transportation and Facilities Branch
- SDA - Liaison Office, Matching Funds Program, State Departments of Agriculture

FAS - Foreign Agricultural Service

FCS - Farmer Cooperative Service

FES - Federal Extension Service





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PROGRESS REPORT  
for  
DAIRY RESEARCH AND MARKETING  
ADVISORY COMMITTEE MEETING  
December 15-17, 1958

I. FARM RESEARCH

A. NUTRITION AND FEEDING

1. Energy Evaluation of Feeds and Pastures

ARS-AH

Problem: More extensive energy metabolism data on dairy cattle is needed and a program of this type of work is required for the most accurate estimation of the nutritional value of feeds, particularly for forages. Interest in this type of work has become important because of the increased emphasis on grassland farming and the necessity of obtaining good nutritional data on the feeding value of forages.

Program: This is basic long-time research, conducted at Beltsville and involving approximately 6 professional Federal man-years per year.

Progress: Facilities for this work have been under development for the past two years, and the laboratory will be in full operation this fall. An existing building has been remodeled to provide six respiration chambers for cattle and the necessary analytical and other laboratory facilities provided. This facility is a significant milestone in the nutritional research program for dairy cattle nationally and internationally.

A portable apparatus which has been used with human subjects and horses to determine energy expenditure at work has been adapted to use with cattle on pasture and will be extensively tested. Preliminary tests, in which the apparatus is attached directly to the trachea of the animal by a surgical procedure, indicate that the surgical interference with the respiratory tract and attachment of the apparatus causes no detectable disturbance of animal activity and function. The apparatus appears capable of measuring and aliquoting the respiratory gases required for energy metabolism determinations in an accurate manner. By attaching the apparatus directly to the trachea, interference by rumen gases, which accumulate in chambers or when nose masks are used with cattle and which necessitates somewhat empirical calculations for determining energy output, is reduced. This apparatus can be used to determine actual tissues respiration whereas in conventional methods of determining energy metabolism in ruminants corrections have to be made for heat released by rumen fermentation.

In energy metabolism studies it is required that extremely accurate measurements of the energy content of feeds and excreta be made with the bomb calorimeter. The usual procedure has been to dry these materials and do the energy determinations on the dried material,



which may result in marked energy losses during drying. A study of energy losses in feces caused by drying under Beltsville conditions has shown that losses averaged 3.27%, a significant loss and suggests that energy determinations on materials subject to loss by drying be done on fresh material. Experiments have shown that samples of fresh feces can be preserved by canning and sterilizing feces without energy loss after prolonged periods of storage. Experiments have also shown that care must be exercised in making energy determination on fresh feces. Alcohol priming of the material is required and small losses of alcohol due to evaporation during the preparation of the combustion mixture can cause serious errors. A satisfactory alcohol priming method has been developed and cross checked with results obtained in other laboratories.

Plans: The energy measurement work will be primarily concerned with improving the basic principles and techniques required for energy evaluations. This includes heat and gas production from rumen fermentation, maintenance requirements and determination of heat increment. Measurements of the energy expenditure of cattle while pasturing will be made. Data accumulated in these trials will be used to estimate the productive energy yields of pastures under varying conditions.

#### Publications

A Proposed Method for the Measurement of the Respiratory Exchange and Energy Expenditure of Grazing Animals. W. P. Flatt, D. R. Waldo, J. F. Sykes and L. A. Moore. ARS 44-27, June 1958. J. Dairy Sci. 41:723, 1958 (Abst.)

Effect of Methods of Preservation and Storage of Fecal Samples on Energy Losses. W. P. Flatt. ARS Inf. Series 52-54. J. Dairy Sci. 40:612, 1957 (Abst.)

A Method for Holding Wet Feces Without Nitrogen Loss. W. C. Jacobson, P. M. Damewood, Jr., and E. A. Kane. J. Dairy Sci. 40:612, 1957 (Abst.)

## 2. Unidentified Nutrients in Foods and Feeds

ARS-AH

Problem: Determine what still unidentified nutrients occur in foods and feeds.

Program: A continuing long-term program in basic nutritional research carried on at Beltsville, involving about 1 professional Federal man-year annually.

Progress: Requirements on weanling rats for dietary essentials, including unidentified factors, are increased by the use of stress agents. When such rats are fed purified diets containing thyroprotein as a stress agent along with ample amounts of all known nutrients, they grow at a suboptimal rate. Previous work has shown that incorporation of certain food materials in the ration improved growth, indicating that these substances contain one or more unidentified nutrients. Continuation of this work has shown that, contrary to some reports, the



nutritional deficiency produced by thyroprotein could not be overcome by including large amounts of fat in the diet, if precautions were taken to ensure that the extra fat did not separate out from the rest of the ration. Such separation could be prevented, even with a level of as much as 30% of liquid fat, such as cottonseed oil, by adding a sufficient amount of an inert material, such as ethyl cellulose, which could absorb the fat, or of an emulsifying agent, such as soybean lecithin.

Plans: Emphasis will be placed upon preparation and purification of active fractions from one or more of the food materials which have been found to contain unidentified nutrients.

3. Relation of Vitamin B<sub>12</sub> to Protein and Amino Acid Metabolism ARS-AH

Problem: Study the manner in which vitamin B<sub>12</sub> prevents serious deleterious effects in rats fed high dietary levels of protein.

Program: A continuing long-term program in basic nutritional research carried on at Beltsville, involving about 1 professional Federal man-year annually.

Progress: Previous work has shown that vitamin B<sub>12</sub> deficiency in weanling rats, as reflected in subnormal growth and failure to survive was much intensified by increasing the level of protein in the ration from 25% to 65%. Tests conducted during the year indicated that this effect is due to the increased protein itself and not to concomitant lowering of the carbohydrate and/or fat level in the ration. In further experiments directed toward determining whether the injurious effects are due to the protein as a whole or to one or more specific amino acids, each of the latter acids composing casein was added to the B<sub>12</sub>-deficient 25% protein ration (20% casein) one at a time in an amount physiologically equivalent to its content in 40% casein. DL-methionine tended to reduce growth slightly. DL-threonine, DL-valine and DL-aspartic acid brought about marked growth depression. DL-serine caused pronounced lowering of the growth rate in 6-week-old rats and death within a few days in 4-week-old animals. None of the other amino acids brought about depression of growth. Feeding a supplement of vitamin B<sub>12</sub> prevented partially or completely the growth depression with threonine and valine but had no effect on that produced by aspartic acid and serine. The vitamin failed to prevent the death of 4-week-old rats fed serine. Comparative tests with the separate D- and L- isomers of aspartic acid showed that the growth depression caused by feeding the racemic mixture was due to the presence of the D- form.

Plans: Similar studies will be carried out with the D and L isomers of other amino acids that have been found to cause growth depression. The investigation of the relation of vitamin B<sub>12</sub> to protein metabolism will be extended.



4. Magnesium and Tocopherol in Dairy Calf Nutrition

ARS-AH

Problem: Magnesium and tocopherol deficiencies sometimes occur in young calves during the milk feeding period and causes losses in calf production. Information is needed on the factors affecting the magnesium and tocopherol requirements of calves and the utilization of these nutrients from different feed sources.

Program: This is relatively short-time basic nutritional research, at Beltsville and at the University of Connecticut under 2 contracts, and involves approximately 2 professional Federal man-years annually.

Progress: While the utilization of magnesium by calves does not appear to be affected by the source from which the magnesium is derived, the amount of magnesium required by calves is affected by diet characteristics. The requirement of calves on whole milk diets has been found to be higher than that of calves on timothy hay and concentrate diets. Calves were fed diets of timothy hay and concentrate supplying .50 to .90 grams of magnesium per 100 lb. of body weight, and these maintained normal serum magnesium values. Bone magnesium values were slightly low. When similar calves were fed whole milk diets which supplied the same quantities of magnesium, serum magnesium values and bone magnesium concentration were decreased. Preliminary experiments in which calcium and phosphorus were added to whole milk diets indicate that these additions may further increase magnesium requirements and that the difference noted in requirement when on timothy hay or milk rations may be a reflection of the high calcium and phosphorus content of the milk diets. Further work is required to establish this possible relationship. The addition of calcium and phosphorus to the whole milk diets tended to increase the incidence of cardiovascular lesions noted in these calves, indicating a need for further study of magnesium, calcium and phosphorus relationships in the etiology of cardiovascular damage.

In studies to determine the magnesium requirement of dairy calves on whole milk diets, it appeared that the amount of magnesium required to prevent deficiency symptoms differed when magnesium was provided as inorganic salts or as a constituent of feedstuffs. The accuracy of recommendations on the magnesium requirements of calves could therefore depend on clearly defining the utilization of magnesium from different sources. Using a whole milk basic ration, an experiment was performed to determine if there were differences in the utilization of magnesium from magnesium sulfate, grain or alfalfa hay when used as a supplement to milk. Magnesium supplied in these diets approximated 1.0 gm/100 lb. body weight. There was a tendency for the Holstein calves to utilize magnesium more efficiently than Jersey calves as indicated by higher serum magnesium concentrations, a smaller decrease in concentration during the trial, a higher concentration of magnesium in bone ash and a higher ratio of bone magnesium to dietary magnesium. This difference was not statistically significant. There was a tendency for calves, irrespective of breed, when supplemented with magnesium sulfate to have lower serum magnesium concentrations, larger decrease in



concentration during the trial, a lower concentration of magnesium in the bone ash and a lower bone magnesium to dietary magnesium ratio than calves supplemented with equivalent amounts of magnesium in the form of grain or hay. These differences were not statistically significant. While the trend indicated better utilization of magnesium from hay or grain than from  $MgSO_4$ , large individual variations in the relatively small population of animals studied reduced the significance of this trend. Recommendations as to the amount of magnesium that would need to be supplied to calves would not appear to need modification to take into account the source from which the magnesium was derived.

In studies to determine the value of artificially dried alfalfa leaf meal as a source of tocopherol (vitamin E) for young dairy calves, the availability of chemically determined tocopherol in alfalfa leaf meal was compared with tocopherol supplied in a dry carrier. Alfalfa tocopherol was equal to "carrier" tocopherol for the maintenance of blood tocopherol levels but when tissue stores of tocopherol were also taken into consideration, alfalfa tocopherol was only about 90% as efficient as the "carrier" tocopherol for maintenance of comparable vitamin E status. This appeared to be due to the fact that the tocopherol contained in alfalfa leaf meal was not readily released during digestion of the alfalfa meal, whereas, the "carrier" tocopherol was in a readily available form. Alfalfa leaf meal is still an excellent source of tocopherol for the dairy calf and the amounts of tocopherol present are sufficient to prevent vitamin E deficiency symptoms in calves when moderate quantities of leaf meal are fed. It was also found that heart and liver tissue concentrations of tocopherol were much more sensitive indicators of vitamin E status than tocopherol concentration in perinephric fat and trapezius muscle.

Plans: The work is continuing.

#### Publications

Magnesium Sulfate, Grain or Alfalfa Hay as Sources of Magnesium to Calves Fed Whole Milk. J. W. Thomas and M. Okamoto. ARS 44-25, June 1958. J. Dairy Sci. 41:724, 1958 (Abst.)

#### 5. Nutritional Requirements for Cellulolytic Rumen Bacteria ARS-AH

Problem: A knowledge of the nutritional requirements of rumen bacteria (cellulolytic) which digest cellulose provides information on the kinds and amounts of specific nutrients which must be present in the rumen of cattle or which may be added to the rumen to maintain optimum digestion of cellulose containing materials (forages) consumed by cattle.

Program: This is basic long-time research in the general field of rumen microbiology as related to ruminant nutrition, and involves approximately 1.5 professional man-years annually.



Progress: Studies on the nutrition of a strain of Ruminococcus flavefaciens, an important species of cellulolytic bacterium of the rumen show that it can be grown in a medium containing cellobiose, minerals, cysteine, B-vitamins, "tween 80", acetate and isovaleric acid. This medium results in less growth than similar media also containing a mixture of 18 amino acids or casein hydrolysate. The addition of clarified rumen fluid greatly stimulates growth over that obtained in any of the media of known composition. The studies showed that "tween 80" (or oleic acid) and acetate stimulate growth in the media of known composition except for casein hydrolysate. Lipoic acid was somewhat stimulatory in the absence of acetate but would not completely replace acetate. A carbon source such as cellobiose and volatile fatty acid such as isovaleric are obligate requirements for growth under the conditions studied. Isovaleric acid could be replaced by isobutyric acid. The effect was not additive. DL- $\alpha$ -methyl-n-butyric or straight chain fatty acids, C<sub>3</sub> to C<sub>6</sub>, each added separately did not replace isovaleric or isobutyric acids and n-valeric acid in combination with isovaleric acid did not increase growth above that obtained with isovaleric acid alone. The organism has no obligate requirement for any amino acid other than cysteine. Data on growth in the presence of crude materials indicate that many materials contain a factor(s) which stimulates growth in the presence of isovaleric acid but not without it and a few materials contain an isovalerate replacing factor. Previous studies on the nutrition of Bacteroides succinogenes, another important cellulolytic species, showed that it required a branched and straight chained volatile fatty acid for growth. Present studies on five strains indicate that most strains require biotin for growth and p-amino-benzoic acid is stimulatory to some. No other vitamins are required or stimulatory in the presence of these two vitamins. Studies on nitrogen requirements are not finished but data indicate that there is no obligate requirements for amino acids with the possible exception of cysteine. Some strains have grown without this amino acid. All grow in media in which cysteine is the sole nitrogen source other than ammonium ion. These studies indicate the volatile fatty acids are important in the growth of two of the most numerous species of rumen cellulolytic bacteria and that nitrogen requirements of these bacteria are very simple.

Plans: Work will be continued on the nature of factors contained in crude materials which stimulate growth of rumen bacteria. The utilization of nutrients required by rumen bacteria will be investigated with isotope techniques.

## 6. Efficiency of Forage Utilization by Dairy Heifers

ARS-AH

Problem: Individual variation in utilization of forages has been observed in dairy cattle. Silages are utilized less well than hay from the same crop. These variations limit the usefulness of these feeds in the economical feeding of dairy cattle.

Program: This is long-term work primarily of an applied nature with some elements of basic research, conducted at Beltsville and cooperatively at two State agri. expt. stas., and involving approximately 3 professional Federal man-years annually.



Progress: Observations on forage consumption by dairy cattle suggest that ability to consume large quantities of hay and silage is quite variable. The relative ability of cattle to consume and utilize forages for growth and milk production is of economic importance to an agriculture stressing grassland farming and this work was started to obtain information on the efficiency of forage utilization for dairy heifers. This work will also possibly provide a basis for developing selection indices and breeding programs to develop cattle with maximum forage utilization ability. The work has shown that heifers differ in their ability to utilize hay. Their gross efficiency was correlated with age and body weight at the beginning of the test period and with dry matter consumed per 100 lbs. of body weight. Gross efficiency and dry matter consumed per cwt. were more closely related to age and weight than was daily gain.

In a limited milk-limited grain-high forage feeding system for rearing young calves the substitution of alfalfa hay by alfalfa silage, a mixture of alfalfa and corn silage, and alfalfa silage plus small amounts of hay or grain has resulted in decreased rates of growth and feed consumption. Supplementing with corn silage accentuated the decreased rate of growth and development, but supplementing the alfalfa silage with 2 lb. of a grain mixture per day for a portion of the growing period improved responses only during the period when it was fed. When this supplement was withdrawn, growth actually failed for a 1-3 month period and the heifers reverted to the status of those fed silage only. A grain mixture containing 16% protein produced somewhat less gain than a mixture containing 27% protein in this limited milk-limited grain-high forage feeding system. It is evident from these results that rations, in which alfalfa silage was the major forage, are not completely satisfactory for dairy heifers.

The reduced growth rates observed in the alfalfa silage feeding experiments with dairy heifers can be accounted for by low dry matter consumption. Heifers consume less nutrients when supplied in alfalfa silage than when alfalfa hay is the source of nutrients. To obtain information on the role of increased water intake on dry matter consumption when alfalfa silage is fed as compared to hay, alfalfa silage was dried to about 90% dry matter content (similar to hay) and fed in unlimited amounts to calves, and dry matter consumption compared to similar calves fed the same silage in wet form. Weight gains and consumption of calves fed dried silage were not improved above that of calves fed wet silage. The drying of silage did not improve its acceptability and voluntary consumption by calves above that of silage in its normal state. Results indicated that the high water content of silage was not the limiting factor in dry matter consumption and that some constituent other than water limited consumption of alfalfa hay by the calf and the resulting body weight gain by soaking the hay with the effluent liquid from a silo containing alfalfa silage. The addition of silage juice to chopped alfalfa hay for a period of 3 to 4 months caused a slight decrease in dry matter consumption and a reduction in rate of growth of 4 calves. Further work to more firmly establish this observation and to determine which constituents contained in silage juice are responsible are in progress. In an effort to increase



palatability and dry matter consumption of alfalfa silage, molasses has been added to the silage at feeding time for four heifers. Two calves were fed a commercial pelleted feed which has been reported to increase forage consumption as an addition to the alfalfa silage ration. Neither of these additions increased dry matter consumption from silage. Determination of the factors which limit consumption of silages is a problem which must be solved in order to take maximum advantage of economic returns that may be realized from making grass-land crops into silage.

Plans: Work will continue on factors associated with individual variation in forage utilization by dairy heifers and to determine genetic influences on forage utilization. Additional groups of animals have been set up to investigate other hay-silage rations than those which have been unsatisfactory in the past. Work will be continued on constituents of silage which limit consumption of silage.

#### Publications

A Comparison of Alfalfa Hay and Wilted Alfalfa Silage Supplemented with Additional Grain or Hay as Roughage for Growing Dairy Heifers. J. W. Thomas, J. F. Sykes and L. A. Moore. J. Dairy Sci. 40:626. 1957.

High Roughage Rations for Dairy Heifers. ARS Production Res. Rpt. No. 15, Dec. 1957.

7. The Identification and Nature of Unknown Nutritional Components of Alfalfa and Other Forages

ARS-SWC

Problem: The discovery, isolation, and identification of factors in forage that contribute to their nutritional quality to permit the evaluation and determination of the corrective action necessary to increase the utilization of and production from forages of low nutritive value.

Program: A long-term program utilizing biological assay procedures with the laboratory and large animal with forages grown under known or controlled conditions, chemical isolation techniques and basic studies of the biochemistry and physiology of the animal at Ithaca, N.Y., in cooperation with the New Hampshire Agr. Expt. Sta., Durham, N.H., and involving about 1 professional Federal man-year annually.

Progress: The deficiency syndrome observed with the cow, calf and rabbit when fed a timothy hay produced on tensively fertilized soils is corrected by supplements of alfalfa in the ration of the calf or rabbit. Supplementation of the timothy diet with known vitamins, additional protein, essential fatty acids, the micro-nutrient elements, alfalfa ash, all failed to improve the growth rate in rabbits. Results suggest that one of the factors contributing to the low nutritive quality of the timothy hay is a cation-anion imbalance. Supplementation of the

timothy diet with potassium acetate, calcium citrate or magnesium oxide dramatically enhanced the growth rate of rabbits. Salts such as calcium phosphate or sodium phosphate are ineffective. This observation presents another vista of mineral nutrition and mineral interrelationships as well as another possible criterion for the evaluation of forage nutritional quality.

Plans: The observation of a cation-anion imbalance in timothy hay for the rabbit will be extended to the ruminant animal by calf feeding trials. The implications of the observed imbalance will be further exploited in the rabbit and in the analytical laboratory.

#### Publications

Growth Studies with Calves and Rabbits Fed Timothy Hay Grown on Heavily Fertilized Soils. H. A. Keener and E. J. Thacker. J. of Dairy Sci. 41:182-189. 1958.

#### 8. The Copper Requirement of Ruminants with Reference to the Inter-relationships with Sulfur and Molybdenum ARS-SWC

Problem: Determination of a basis for the diagnosis and treatment of nutritional disturbances in livestock apparently caused by toxic quantities of molybdenum in forage.

Program: A three year program of dairy cattle trials with differential intakes of molybdenum has been established in a contract between the New Hampshire Agr. Expt. Sta., Durham, N. H. and the U. S. Plant, Soil and Nutrition Laboratory, Ithaca, N. Y., involving less than 1 professional Federal man-year annually.

Progress: Different levels of molybdenum were given to Holstein first-calf heifers fed a basal ration low in copper ( $< 5$  ppm), molybden ( $< 1$  ppm) and sulfur ( $< 0.15\%$ ) composed of timothy hay and a concentrate. Molybdenum fed for 10 months at a level of 50 ppm in this ration, has had no apparent adverse effects on the lactating cow as measured by condition, blood hemoglobin levels and lactation. Chemical analysis of periodic liver biopsy, blood and milk samples show that a close relationship exists between the molybdenum fed and its concentration in these tissues. Copper concentration in these tissues apparently is not influenced by the level of molybdenum fed.

Plans: In view of the reported effect of the sulfate ion on the toxicity of molybdenum, an experiment will be carried out in the second year that will examine the effects of molybdenum in the presence of high levels of the sulfate ion in the ration.



9. Integration of Soil and Water Management Practices for Conservation Farming

ARS-SWC

Problem: Applying soil and management practices developed in the laboratory or on small field plots to field and farm size operations under practical farm conditions.

Program: A long-term program of testing and integrating newly developed practices to see if they will perform satisfactorily or economically at the Southern Piedmont Expt. Sta.

Progress: At Watkinsville, Ga. (coop. FE) a net loss occurred during the second and final transition year for the development of an enlarged Grade B dairy unit although gross income was 29 percent higher than in 1956. The loss resulted from extra costs involved in establishment of permanent pastures, purchase of additional milk cows and adverse weather conditions which affected yield and quality of crops produced. The use of parallel terraces on the unit resulted in an estimated savings of 25 percent in row crop production time.

Plans: This study will be continued over a period of years.

B. FORAGE, PASTURES AND SILAGE

1. Predominant Bacterial Occurring in Silage Identified

ARS-AH

Problem: The fermentation process which occurs during the storage of plant materials as silage is predominantly a result of the action of bacteria contained in the silage. Silage quality is related to the kinds of bacteria which develop and the products that they produce during fermentation. A complete description of the kinds of bacteria which occur at various stages of silage preservation is important in the improvement in preservation of grassland crops.

Program: This is long-time basic research conducted at Beltsville, and under contract at Indiana University, and involving about 2.5 professional man-years annually.

Progress: Five genera of bacteria have been identified in experimental silages of various quality and made from orchard grass, alfalfa or corn silage. Four hundred and forty-four strains of organisms out of a total of 3142 organisms isolated have been studied in considerable detail. These studies indicate that the organisms belong in the genera Streptococcus, Pediococcus, Leuconostoc and Lactobacillus with a fifth unidentified genus consisting of coccus to rod forms. These studies



also indicate that bacteria of the genera Pediococcus and Lactobacillus are of particular importance in silage preservation since they occur in greatest numbers.

Isolated cases of botulism poisoning with resulting loss of cattle have been reported in cattle fed silage. Several samples of silage that were reported to have caused death in cattle were studied. Silage was obtained from a silo which was reported to be causing losses on a Maryland farm and fed to cattle at the University. Bacteriological examination of the silage fed was made during the feeding trial. No effect of feeding this silage was noted. Botulism organisms (Clostridia) were not isolated from any of the suspected silages examined and injection of silage extracts into rats failed to reveal the presence of a toxin. These tests have failed to identify botulism as a cause of loss in the cattle fed these silages. On the other hand, the possibility exists that botulism toxin may be produced in small pockets of silage in the silo, which could be removed in a matter of 2 or 3 days feeding. Since small amounts of toxin can be very damaging, losses could occur during this period with no traces of toxin or organisms present in the remaining silage. Continued examination of this possibility is warranted.

Plans: Work will continue on further, more detailed identification of bacterial strains and on the physiological activity of these bacteria and their relation to silage quality.

#### Publications

Microbiological and Chemical Changes in Silage. C. W. Langston, H. Irvin, C. H. Gordon, Ceclia Bouma, H. G. Wiseman, C. G. Melin and L. A. Moore. ARS 44-21, June 1958. J. Dairy Sci. 41:734, 1958 (Abst.)

## 2. Forage Production and Utilization from Pastures

ARS-AH

Problem: Maximum production of feed for dairy cattle from pastures is of major importance to milk producers in efforts to improve efficiency of production.

Program: This is production research of rather short duration, carried on at Beltsville and in cooperation with 4 State agricultural experiment stations and involving approximately 3 professional Federal man-years annually.

Progress: Work has been started on the split-herd grazing system as a means of increasing yields from pastures. In this system, the rotation of cattle through pasture plots is arranged so that the highest producing cattle in the herd are turned into new pasture for a short period and when they are moved to the next plot, the lower producing cattle in the herd are moved into the plot partially grazed by the higher producers. In the conventional rotation grazing the whole herd, including low and high milk producers, is moved from plot to plot together. The results indicate that some increase in yield of nutrients



from pasture may be obtained from the split-herd system provided that sufficiently large differences in milk production level exists between groups. The dry season experienced during this pasture season materially reduced all pasture production and it seems possible that with better pasture seasons a larger difference between the split-herd and conventional systems might occur.

Work designed to study the factors involved in a year-round forage feeding program under Tennessee conditions is underway. It includes production of pasture, hay and silage and the use of grass-legume mixtures and summer and winter annual forages (sudan grass, rye and crimson clover). The effect of irrigation on yields and cropping systems is included. During the year, the yields from the summer annuals (sudan grass) have been very low on the unirrigated land and it is concluded that this crop is not an efficient method of increasing feed supplies in dry summers without irrigation. The yield of 4% fat corrected milk from all pastures on the unirrigated land was 5112 lbs. per acre and from the irrigated land 6105 lbs. per acre. In addition, 1220 lbs. of hay and 14,000 lbs. of silage per acre was produced on the unirrigated lands as compared to 4600 lbs. of hay and 29,000 lbs. of silage per acre on the irrigated land. This work demonstrates the high yields of nutrients which may be obtained from grassland crops when properly managed and the marked increases that may be obtained by applying irrigation.

Plans: The work will continue on the present basis for 2 to 3 years when it should be completed.

### 3. Preservation of Silage Nutrients in Bunker Silos Improved

ARS-AH

Problem: Loss of nutrients during storage of grassland crops in various types of silos can result in considerable economic loss and reduction of feeding value of grassland crops. In tower silos marked losses of nutrients occur due to seepage when high moisture (direct-cut) forages are ensiled and there is frequently some decrease in feed quality. In bunker silos losses from top spoilage and leaching can also be severe. These losses are important factors in recommendations that should be made to farmers concerning the most suitable and economical type of structure to use for storing grassland crops.

Program: This is a practical problem of limited duration, conducted at Beltsville and cooperatively at 3 State agricultural experiment stations and involves approximately 4 professional Federal man-years annually.

Progress: Losses from storing high moisture forages in tower silos can be reduced by wilting the forage before it is stored. Dry matter loss was 13.8% when wilted forage was stored in a tower silo. High moisture forage stored in a similar silo with an added preservative (sodium metabisulfite) lost 20.9% of the dry matter stored. The wilted silage was consumed in greater quantity by cows and the cows produced more milk on this silage than when fed the high moisture silage. When



high moisture forage with metabisulfite preservative was stored in a well sealed bunker silo, dry matter loss was 14.8%, and the quality and feeding value of the resulting silage was comparable to the wilted silage. A very effective seal on this bunker silo was largely responsible for this unusually successful storage. This work demonstrates the quite high losses that can occur when high moisture (direct-cut) forages are stored in conventional tower silos, and that these losses can be minimized in bunker silos, which are usually less expensive than tower silos, if the silage is properly packed and protected from the atmosphere and rainfall. Similar work at Lewisburg, Tenn. and Puyallup, Wash. has also shown that nutrient losses in bunker silos may be reduced by 10-15% when plastic covers are used for protection. At Lewisburg, the total loss in a well sealed bunker silo was 16%. This compares very favorably with the losses usually experienced in the more conventional silos.

Further work has been completed on the development of chromatographic separation of silage acids. Last year a method suitable for analysis of butyric, propionic, acetic, formic, lactic and succinic acid was reported. During the year this method has been extended to include the separation of other organic acids (citric, malic and malonic) normally present in fresh plant material. With some modification oxalic acid may be determined. These analyses will enable researchers to more fully explore compounds required or used for the production of acidity in silage fermentation. This method is being widely adopted.

Plans: This phase of the program should be completed in 2 to 3 years. Investigations have been initiated on the usefulness of other types of plastic covers, on plastic bag silos and on gas-tight storage for silage preservation.

#### Publications

The Improvement of Forage Preservation in Bunkers and Stacks Through the Use of Temporary Seals. C. H. Gordon and J. R. McCalmont. J. Dairy Sci. 40:619, 1957 (Abst.); ARS Inf. Series 52-55, 1957.

Some Experiments in Preservation of High-Moisture Hay-Crop Silages. C. H. Gordon, H. M. Irvin, C. G. Melin, H. G. Wiseman and J. R. McCalmont. J. Dairy Sci. 40:789, 1957.

The Nutrient Losses and Feeding Value of Wilted and Direct Cut Forages Stored in Bunker and Tower Silos. C. H. Gordon, C. G. Melin, W. C. Jacobson, H. G. Wiseman, E. A. Kane, J. E. Derbyshire, J. R. McCalmont and D. T. Black. ARS 44-25, June 1958. J. Dairy Sci. 41:735, 1958 (Abst.)

Determination of Organic Acids in Silage. H. G. Wiseman and H. M. Irvin. Agr. and Food Chem. 5:213, 1957.



4. Use of Irrigation on Coastal Bermudagrass Pastures

ARS-CR

Problem: Drouths affecting permanent pastures in humid regions of the U. S. have resulted in a demand for information on the value of pasture irrigation.

Program: This is a long-time study of the effects of irrigation on pasture production using Coastal bermudagrass -- one of the most productive pasture grasses in Southeastern U. S. -- in cooperation with the Georgia Agr. Expt. Sta., Tifton, Ga.

Progress: In 1957 natural rainfall was well distributed and only 5 inches of supplemental irrigation was required. During the 5 month grazing period the non-irrigated pastures produced an average daily gain of 934 lbs. of beef per acre. The irrigated pastures produced 954 lbs. per acre. As was the case in 1956, irrigation did not increase individual animal gains, although it did increase the carrying capacity. The small increase in return has not paid for the extra cost of irrigation.

Plans: This experiment has been terminated.

5. Relationship of Stage of Maturity and Chemical Composition to Forage Digestibility

ARS-CR

Problem: Forage quality changes markedly with stage of maturity and plant species.

Program: Forage quality studies as related to stage of maturity and species are underway in cooperation with the Pennsylvania and North Carolina Agr. Expt. Stas.

Progress: In Pennsylvania forage samples of known digestibility were analyzed with the object of relating chemical composition to nutritive value. The lignin content and ether and alcohol fractions was used in a predictive equation to estimate the digestible dry matter in grass. The equation developed was accurate regardless of grass species but the same mathematical relationship between lignin and digestibility did not exist for alfalfa. A better knowledge of the complex carbohydrates of cell walls is necessary before the processes of digestion by ruminants can be understood, and perhaps before differences in nutritive value and palatability of forages can be explained. The hemicelluloses of grasses were analyzed for their components. In brome grass four sugars, two uronic acids and five aldobiuronic acids were identified on paper chromatograms. The sugars were determined quantitatively and xylose was found to be the most abundant. In North Carolina established stands of alfalfa and tall fescue were harvested on successive dates as maturity increased. The forage was dried, ground and fed to yearling sheep to determine the digestibility of standard chemical constituents as well as that of several constituents not widely reported in the literature. Special attention was given to the lignin and carbohydrate fractions of the feed. Several exploratory regression equations calculated thus far indicate that alfalfa



results give equations with fair predictive value. While the fescue data has afforded no satisfactory equations to date.

Plans: Attempts are being continued to develop better chemical techniques for the determination of lignin and it seems likely that an improved procedure will be available shortly. Methods are being perfected for a more effective determination of hemicellulose since it has been demonstrated that losses of this compound occur during their isolation.

6. Silage from Surplus Pasture Growth

ARS-CR

Problem: In the Gulf Coast area highly palatable silage can be made from the spring flush of growth of pasture grasses and clovers. This high quality forage may not be fully utilized in most livestock programs. Yet feed is sorely needed in other seasons. Preliminary work is being conducted in cooperation with the Texas Agr. Expt. Sta. at Beaumont to determine ways for saving surplus pasture growth as silage.

Progress: Preliminary work indicated that the following precautions should be observed to insure high quality silage: (a) optimum moisture for ensiling 65-75%, (b) uncovered stack silos failed to preserve forage and losses were almost 100%, preservation in plastic bag silos produced highly satisfactory silage, and (c) sodium metabisulfite was a satisfactory preservative.

Plans: This work will be continued using new-type bunker silos.

7. Genetics and Breeding for Spotted Alfalfa Aphid Resistance

ARS-CR

Problem: Develop new and improved varieties of alfalfa that are resistant to the spotted alfalfa aphid and adapted to the respective physiographic regions of the 30-state area where the aphid is a problem.

Program: A continuing breeding program involving about 2 professional Federal man-years annually is being carried on cooperatively with the Nevada, Nebraska, and Kansas Agr. Expt. Stas.

Progress: The winter tender variety Moapa, which followed Lahontan as the second spotted aphid resistant alfalfa developed in Nevada, was released in August 1957. It is best adapted to Arizona, southern California, and Nevada. When the aphid was controlled chemically, Moapa equalled its parent but aphid susceptible variety African in yield, in tests conducted in the Imperial Valley of Calif. Moapa exceeded the annual production of African by 61% in the absence of chemical control. The 6,000 lb. of foundation seed produced in 1957 will result in an estimated production of 2,000,000 lb. of certified Moapa alfalfa seed during 1958.

Progress is also being made in the development of aphid resistant varieties for the Central Plains region. Susceptibility has been found to be dominant to resistance.



Plans: Studies to develop resistant varieties which are adapted to other segments of the aphid stricken area are being continued.

#### Publications

Breeding Alfalfa for Disease and Insect Resistance. O. F. Smith. Grassland Proceedings 6-14. Ann. Program of the Joint Com. on Grassland Farming, Stanford U., Palo Alto, Calif. Aug. 1957.

Resistance to the Spotted Alfalfa Aphid in Lahontan Alfalfa. W. L. Howe and O. F. Smith. J. Economic Ento., Vol. 50(3). 1957.

Progress in Western States in Breeding for Resistance to Spotted Alfalfa Aphid. H. O. Graumann. Proc. 9th Eastern Alf. Imp. Conf. July 1957.

Lahontan Alfalfa. O. F. Smith. Nev. Exp. Sta. Circ., Spp 1957.

Lahontan Alfalfa Withstands Ravages of Spotted Alfalfa Aphid. O. F. Smith. Seed World, Vol. 80(4). Feb. 1957.

#### 8. Brush and Weed Control

ARS-CR

Problem: Control of brush and weeds on rangelands and pastures is concerned with finding more effective methods of control through the use of herbicidal, mechanical, biological and managerial techniques or combinations of these.

Program: Basic physiological and applied studies of a continuing nature by 25 professional Federal employees in 15 States; New York, Georgia, Indiana, Missouri, Louisiana, Mississippi, Texas, Oklahoma, Nebraska, Arizona, Utah, Idaho, Washington, Oregon, and Nevada.

Progress: Mesquite: In Arizona, preliminary studies of the use of 2,4,5-T for control of velvet mesquite seedlings have indicated that the maximum distance of herbicidal movement from the treated leaf toward the roots is a function of herbicide formulation and concentration as well as surfactant concentration. The two factors appear to be about equivalent in importance within the concentration range studied. It was found possible to control translocation of the herbicide from the leaf into the stem and root by adjustment of either the 2,4,5-T or surfactant concentration. External factors such as climatic conditions affected results.

Better control of mesquite resulted from aerial applications of 1/3 lb/A of 2,4,5-T in each of two successive years than from 3/4 lb. in a single treatment. An ester formulation was consistently more effective and gave maximum effect over a wider range of time than an amine salt form. Leaf moisture, air temperature, soil temperature, relative humidity, and carbohydrate content in the root xylem were not correlated with mesquite susceptibility to 2,4,5-T. Pelleted monuron, containing 25% monuron, showed promise for controlling mesquite, 1/8-in. pellets seemed more effective than 1/2-in. pellets, especially at low rates.



Juniper: Seed survival studies in Arizona showed that Utah Juniper seeds are viable after at least 45 years in dry storage. All samples of stored alligator, one-seed, and Utah Juniper seeds tested contained viable seeds, indicating these species have seeds capable of surviving extended drought periods. Preliminary research with the chlorinated benzoic acid herbicides indicated they have some promise for control of juniper species on rangelands, when used as foliage sprays.

Oak: Aerial applications of 1 lb/A of a low volatile ester of 2,4,5-T to shinnery oak for three successive years in plots at Woodward, Okla., gave an 88% kill of the brush plants. Spraying for only two years gave a kill of 62%, while a single spraying resulted in 21% kill. There was a four-fold increase in oven-dry forage in 1957 resulting from three annual treatments of 2,4,5-T. There was 2,215 lb. of dry matter produced on the sprayed, as compared to 540 lb/A on the adjacent unsprayed areas. Strip applications of substituted urea herbicides looked promising for control of shinnery oak. Fenuron was more effective than monuron in controlling shinnery oak, and it was less detrimental to range grasses. Rates of 3 to 5 lb/A killed in excess of 90% of the shinnery oak.

Gallberry: In Georgia, gallberry was about 80% controlled with 2 lb/A of 2,4,5-T in water when applied in August to regrowth that developed following burning in March. Similar results were obtained if 2,4,5-T was applied in diesel oil in November to either burned or unburned plots.

Persimmon: The tops of persimmon trees in Missouri were all completely killed by foliage sprays consisting of 4 lb. of 2,3,6-TBA in 100 gal. of water. There was no resprouting one year following treatments.

Weeds in Pastures: In a long-term study in Nebraska, the numbers of many perennial weeds sharply increased in untreated and mowed plots as a result of the favorable moisture in 1957. In contrast, those plots sprayed with 2,4-D continued to show excellent control. Annual treatments of the native pasture with 2,4-D gave great improvement in the yield of desirable forage. In these experiments, the largest amount of desirable vegetation was produced in plots plowed, reseeded to adapted grasses and supplementally sprayed with 2,4-D. In other experiments, the addition of diesel oil as an emulsion in water in the 2,4-D spray greatly increased its effectiveness on ironweed.

Cypress weed in pastures was controlled with 2,4-D, 2,4,5-T and silvex when applied at 2 lb/A under Mississippi conditions in 1957. When these herbicides were applied at 1 lb/A only fair control resulted.

In Oregon, a mixture of 2 lb/A of 2,4-D and 3/4 lb/A of 2,4,5-T was used effectively in controlling weeds in a mountain meadow area reseeded with a grassland drill. Good control of western yarrow, eriogonum, penstemon, aster, cinquefoil, and fleabane resulted.



At Beltsville, 2,3,6-TBA was more effective in killing wild garlic than was 2,4-D. The treatment also showed promise for control of red sorrel.

The ester formulations of 4-(2,4-DB) at low rates appeared to be more effective than the amine salt for control of broad-leaved weeds in new seedings of alfalfa, clovers, and birdsfoot trefoil in New York, Nebraska, Missouri, Wyoming, Oregon, and Beltsville. Neburon showed promise for this use in alfalfa for control of both weed grasses and broad-leaved weeds when applied pre-emergence. EPTC also gave promising results when applied pre-emergence to legume seedings.

In Nebraska, five varieties of alfalfa, Buffalo, Grim, Ladak, Ranger, and Vernal, showed no differential response when sprayed 2 weeks after emergence with 4-(2,4-DB), dalapon, or a combination of the two. These treatments gave effective control of broad-leaved weeds and weed grasses with benefit to the new seedings.

Yields of legume hay up to 3,000 lb/A dry weight were obtained in the year of establishment in New York by the use of post-emergence herbicides. Control of both broad-leaved weeds and weed grasses was obtained in the establishment of alfalfa and birdsfoot trefoil with treatments of dalapon, 4-(2,4-DB), and DNBP. Herbicides were more effective when applied in combinations rather than when used singly.

Herbicide Residues: Residue of dalapon occurred in milk from animals fed dalapon at a constant rate of 300 ppm. A maximum residue of 2.45 ppm. was obtained within 7 days of feeding. Dalapon feeding of 300 ppm. based on dry matter intake had no detrimental effects on the animals with respect to milk production, butterfat percentage, body weight, feed intake, or animal behavior.

Spray treatments with silvex, 2-(2,4-DP), and 2-(MCPP) gave consistent kills of bedstraw in experiments in New York. Spring applications of 3 to 5 lb/A were most effective. These materials showed promise for selective use in established birdsfoot trefoil and warrant further investigations.

Halogeton: In Utah, studies on the biochemical and physiological reactions of halogeton showed that black seeds were especially vigorous as compared to brown seeds. Brown seeds almost never germinate under laboratory conditions. It was found that they could be made to germinate by soaking the seed for 24 hours, excising the embryo and incubating them on moist filter paper under strong light. These studies reveal the various phases of the life cycle of this plant and therefore aid in developing methods for its control. Halogeton has continued to spread in the arid western rangelands. In a uniform experiment conducted at six locations in Utah, Nevada, and Idaho, 2,3,6-TBA at 2 lb/A was found to be the most uniformly toxic herbicide evaluated. It was also most toxic to the associated forage vegetation.



New Chemicals: Some of the L, D, and DL amino acid derivatives of the alphaphenoxypropionic acids possessed significantly different selective herbicidal properties than the parent acids. Those appearing to have greatest potential value as post-emergence herbicides for weed control in soybeans, white clover, red clover, and alfalfa were N-2-(2,4-DP)-L-leucine, -methionine, and -threonine. Further studies of these compounds are planned in order to determine their value for the control of weeds in these crops.

Plans: Work underway will be continued with increased activity in cooperative reseach with FS in the control of chaparral in Arizona, and increased work in brush control in the southeastern piney woods. Research work on weed control in pastures and rangelands will continue to emphasize ecological and herbicide studies on range and pasture weeds. These studies will include brush control, control of weeds in permanent pastures in the humid pasture areas, and studies on the control of weeds in seedling establishment in all areas.

#### Publications

Influence of Various Components on the Effectiveness of 2,4,5-T Sprays. R. Behrens, Weeds 5(3). 1957.

Broomweed Invasion and Control in Native Grass Pastures and Rangeland, Central Oklahoma, 1957. H. M. Elwell. Proc. 14th NCWCC. 1957.

An Evaluation of Three Substituted Urea Compounds for Pre-Emergence Control of Halogeton. R. H. Haas, H. L. Morton, and P. J. Torrell. WCC Res. Prog. Rpt. (Abst.). 1958.

Interrelations of Methods of Weed Control and Pasture Management at Lincoln, Nebraska. 1949-55. D. L. Klingman and M. K. McCarty. USDA Tech. Bull. 1180. 1958.

Control of Undesirable Plant Species on Rangelands. D. L. Klingman. Handbook - ARS-SCS Conf. 1958.

Some Factors Affecting Seedling Establishment in Weedy Bluegrass Pastures of Eastern Nebraska. J. L. Cox and M. K. McCarty. J. Range Management. 1957.

The Effects of Rate and Date of Dalapon Application on Control of Medusa-head Rye (Elymus caput-medusae). H. L. Morton, P. J. Torrell, and R. H. Haas. WCC Res. Prog. Rpt. (Abst.). 1958.

Case for the Seeded Firebreak. F. A. Peevy and J. T. Cassady. Forest Farmer 16(1). 1957.

Some Characteristics of Soils and Associated Vegetation Infested with Halogeton glomeratus. W. C. Robocker. J. Range Management. 1958.

Bedstraw-A Weed to be Reckoned With. M. M. Schreiber. Hoard's Dairyman. 1958.

Phreatophytes - Water Wasters - A Menace in the Arid West. F. L. Timmons. Crops and Soils. 1958.



Publications (continued)

Effect of Mesquite on Range Productivity. F. R. Tschirley. Arizona Cattlelog. 1957.

Sodium Accumulation and Oxalate Formation in Halogeton glomeratus. M. Coburn Williams. WWC Res. Prog. Rpt. 1958.

C. PHYSIOLOGY AND REPRODUCTION

1. Physiological Studies Related to Reproduction in Cattle

ARS-AH

Problem: It is recognized that more basic physiological information is required to understand the causes of infertility in cattle and to devise means of preventing losses to producers from infertility.

Program: This is basic long-time physiological research, conducted at Beltsville and cooperatively with 6 State agr. expt. stas., and also coordinated with the Northeast and Western regional projects on infertility of cattle, involving approximately 12 professional Federal man-years annually.

Progress: (a) Body temperature variations related to reproductive activity. The body temperature of dairy cows fluctuates with the estrus cycle, being lowest on the day before heat, high on the day of heat and low again at the time of ovulation and rather steadily high during the luteal phase of the heat cycle. A marked drop in body temperature in pregnant cows immediately preceding calving was noted. Experiments have shown that progesterone (the hormone secreted by the corpus luteum in the ovary) maintains the body temperature of cows at a high level. This observation suggests that the fluctuations in temperature noted during the heat cycle or during pregnancy may be an indication of varying corpus luteum function. Measurement of body temperature may be a useful means not only of determining the presence or absence of ovulation but also a means of detecting variations in corpus luteum activity.

(b) Mechanism of action of uterine defense reactions related to infertility. A relationship has been found between bactericidal activity of the uterus and the level of fertility in dairy cattle. Investigations have been conducted with rabbits, in which similar uterine responses are obtained, on reactions involved in the endocrine-controlled uterine defense mechanism. An association was found in estrous rabbits between leukocytic migration into the uterine lumen and bactericidal activity of the uterus during the early stages of uterine infection. Leukocytic response was slower in pseudopregnant rabbits and was not associated with bactericidal activity. Leukocyte-free exudate from previously inoculated estrous rabbits was bactericidal to E. coli both in uteri of pseudopregnant rabbits and in vitro, and possessed greater bactericidal activity in vitro than similar exudate from pseudopregnant rabbits.



Blood serum and leukocytes were investigated as possible sources of the bactericidal substance in uterine exudate. Serum was bactericidal in utero and in vitro, but lost its bactericidal properties when heated at 56° C. for 30 minutes while uterine exudate retained strong bactericidal activity. Leukocytic extracts contained substances which were highly bactericidal in vitro and were heat-stable at 56° C. for 30 minutes; the bactericidal activity of uterine exudate may be due to diffusion or release of bactericidal substances from leukocytes. These experiments have delineated some bactericidal reactions which occur in the uterus.

(c) Assay of body fluids and tissues for estrogenic hormones. The successful use of hormones in treatment of infertility of cattle is hampered by lack of knowledge of the levels of hormones present in normal and abnormal animals. Attempts to establish correlations between blood and urine levels and the estrus cycle activity have so far been unsuccessful. During the year data concerning the estrogen content of bovine saliva has been collected using a sensitive bioassay technique adapted for this purpose. To date 41 samples of bovine saliva from 12 different cows have been assayed. Small quantities of estrogenic substances are present in bovine saliva but more samples must be assayed before any definite statements can be made in regard to variations in estrogen content of saliva during the estrous cycle. Assays of tissues from lambs fed stilbestrol have also been carried out. A small, but significant increase in the estrogenic content of the fat of the stilbestrol treated lambs has been found. Estrogenic activity has also been found in extracts of commercial rabbit feed, a commercial dog feed, and cull red kidney beans. No measurable estrogenic activity has been found in fluid aspirated from an ovarian cyst (bovine), nor in extracts of several samples of grass silage, one of which consisted largely of Ladino clover.

(d) Cytological variations in the bovine corpus luteum during early pregnancy. The corpus luteum is important in the maintenance of pregnancy of all species of animals. Presumptive evidence suggests that early embryonic mortality is related to abnormal corpus luteum function. This work has described the cell types of the corpus luteum and the relation of these to reproductive performance. The lutein cells of bovine corpora lutea recovered from cattle slaughtered between 16 and 30 days of gestation can be grouped into five types on the basis of their cytological characteristics. Type I cells represent "immature" lutein cells and Type II cells are mature cells which have reached their maximum size and development. Type III cells are believed to be in the initial stage of regression which continues through Type IV cells and terminates with Type V cells. Between 16 and 30 days of gestation, there is an increase in the number and the size of the Type II cells with a corresponding reduction in I's. Lutein tissues with high percentages of Type III, IV and V cells, especially Type IV cells, are considered to be abnormal. The cytological changes in the bovine corpus luteum during early pregnancy coincide with advancing gestation and are related to the reproductive performance of the individual animal.



Corpora lutea from cattle which have experienced reproductive difficulty tend to contain a high proportion of Type III, IV and V cells.

(e) Determination of amounts of progesterone in the corpus luteum. Since the corpus luteum through secretion of the hormone progesterone is of paramount importance in maintenance of pregnancy, it is desirable to determine the amounts of progesterone in the corpus luteum and the relation of variations in progesterone content to infertility and embryo loss. A method has been developed and checked for accuracy in measuring progesterone by physico-chemical and biological tests and it appears that the method is sufficiently accurate for routine use in studies of corpus luteum function.

(f) Early embryology of the cow partially characterized. The establishment of normal standards of embryo development in the cow is required as background for studies on factors affecting embryo survival in cattle. Studies have shown that a high proportion of embryos fail to survive beyond 16-20 days of gestation in repeat breeder cows. Sixteen embryos recovered from cows and heifers slaughtered at 16 to 18 days following breeding were studied to determine their morphogenetic characteristics. Included in the group were 6 16-day-old embryos, 5 17-day-old embryos, and 5 18-day-old embryos. The bovine embryos from 16 to 19 days were approximately comparable to the human embryo of 14 to 19 days, to the ovine embryo of 10 to 13 days, and the porcine embryo of 9 to 12 days. The embryonic development has been described in which some variations were noted. The variations within each of these 3 days of gestation was undoubtedly due in part to a lack of precise knowledge of ovulation and fertilization times. This fact does not eliminate the possible influences of other factors, such as individual variation, dam age, breed, and uterine environment. Two cases of probable embryonic death were encountered, in which the trophoblast persisted after loss and resorption of the embryonic area. The early development of the bovine heart was also studied in seven timed embryos recovered 21 and 22 days after insemination. Further characterization of the normal development of the bovine embryo will be necessary before it is possible to study the changes which take place in the early embryonic death.

(g) Antigen incompatibility between mother and embryo not a factor in embryo loss. Immunizing cows against the blood of the bull used to service them did not affect the fertility of these cows nor did it produce any evidence of hemolytic disease in the calves resulting from these matings. The effect of immunization against semen has been investigated. Seventeen heifers exhibited anaphylactic-like reactions after repeated injections of bull semen intravenously. When the heifers were bred to the bull whose semen they had received, eight conceived on first service and three of the remaining nine conceived on the second. The six remaining heifers were killed three days after the third or fourth breeding; fertilized ova were recovered from three of them, unfertilized ova from the other three. The reproductive organs all appeared normal. The results so far as fertility is concerned did not, on these small numbers, appear different from those usually obtained



with artificial insemination. Serological tests failed to indicate that sperm agglutinins had been formed as a result of the injections in any of the seventeen heifers. They also failed to indicate that any antibodies had been formed which were cross-reactive with the red blood cells of the bull who was the semen donor. Sperm will be tested to determine if they do contain any antigens in common with the bull's red blood cells. Preliminary complement-fixation tests suggest that in some heifers an in vitro antibody response was obtained. Further studies will be made on the serum samples in an effort to determine if there was any association between in vitro antibody response and reproductive performance.

Plans: This work will be continued for at least 5 years. Certain lines of activity within the overall program will be curtailed or eliminated as the work underway is completed and replaced with other lines as experience and prospects for solution of the problem dictate.

#### Publications

Body Temperature Variations in Dairy Cattle During the Estrus Cycle and Pregnancy. T. R. Wrenn. J. Animal Sci. 16:1095, (Abst.). 1957.

Investigations on the Endocrine-Controlled Defense Mechanism of Estrus and Pseudopregnant Rabbit Uteri. H. W. Hawk, J. Simon, S. H. McNutt and L. E. Casida. Amer. J. Vet. Res., 18:171. 1957.

The Influx of Leucocytes and Presence of Bactericidal Substances in Inoculated Uteri of Estrous and Pseudopregnant Rabbits. H. W. Hawk. J. Animal Sci. 17:416. 1958.

Bacterial Studies of Uteri of Clinically Normal Cows of Low Fertility. H. W. Hawk, C. A. Kiddy, J. B. Wilson, Marcia Esposito and A. J. Winter. J. Dairy Sci. 41:120. 1958.

A Rapid Method for the Purification and Quantitative Estimation of Progesterone from Luteal Tissue. R. G. Loy, W. H. McShan and L. E. Casida. J. Biol. Chem., 229, 583. 1957.

#### D. BREEDING

##### 1. Genetic and Environmental Factors Influencing Dairy Cattle Adaptability

ARS-AH

Problem: The efficiency of the Southern dairy farmer can be improved by developing cattle which are productive and profitable in hot and humid areas.

Program: A long-time study requiring basic and applied investigations in genetics, physiology and management, conducted in seven herds representing five different breeds located at Beltsville, Georgia, Texas, and Louisiana, involving approximately 2.5 Federal professional man-years annually. Several of the studies contribute to the Southern Regional Dairy Cattle Breeding Project.



Progress: (a) Genetic methods for developing adaptability. All of the Sindhi-Holstein  $F_1$  crosses at Beltsville have completed at least one lactation. The first lactation records of the 13 crosses averaged 5,781 lb. of milk, 5.33% butterfat and 308 lb. fat. The average calving age was 2 years, 1 month, and the mean lactation length was 256 days. This was 50% below the dam's average for milk and 44% for fat. The performance of this group has been similar to the Jersey crosses in showing poor persistency and fractious temperaments.

A comparison of the milk production of 17  $F_1$  Sindhi-Holstein crossbreds and their 17 Holstein controls in Louisiana showed that the crossbreds produced approximately 46% less milk and 30% less fat than the controls. The production of the  $3/4$  Holstein-Sindhi crosses was about the same as that of the  $F_1$  crosses. In view of these results and the limitation on the number of animals which could be maintained, the Red Sindhi-Holstein crossbreeding has been discontinued except for such animals as will be in the physiological studies of heat tolerance.

Nine of the  $3/4$  Jersey -  $1/4$  Sindhi crosses at Beltsville have completed first lactation records which average 7,267 lb. milk, 5.92% butterfat and 430 lb. fat in 305 days. The average calving age was 2 years, 2 months. This group averaged 227 lb. milk and 34 lb. fat more than their dams and tested slightly higher. The range in production has been much less than that of any of the other Sindhi crossbred groups tested.

An analysis was made of the growth and body dimensions for the various combinations of Sindhi and Jersey breeding at Jeanerette, La., Beltsville, and Tifton, Ga. The crosses were heavier than the Jerseys at earlier ages, but only  $F_1$ s at Jeanerette and Beltsville,  $3/4$  Jerseys at Tifton, and  $3/4$  Sindhi at Jeanerette held this weight advantage through first lactation. Sindhi-Jersey crosses were taller at early ages but the Jerseys had the advantage by first lactation. Jerseys were longer than the crosses at all ages. At 6 and 12 months the crosses had greater depth than the Jerseys but this gradually shifted to favor the Jerseys at the later ages. Widths followed this same pattern. The data indicated that only  $F_1$ s had permanently greater circumference of forechest. Jerseys had superiority in other circumferences. The crossbreds tended to resemble the Sindhi more closely in appendages. The results suggest that heterosis was exhibited generally in the growth of Sindhi-Jersey crosses at the earlier ages but its expression tended to decrease with age.

A study of the effect of season of calving at Jeanerette on milk production in Jerseys and Sindhi-Jersey crosses showed significant effects in both groups with the greatest effect in Jerseys. Lactations initiated during July to September were lower than in other seasons. The Jerseys and Sindhi-Jersey crosses showed less persistency of production than normally expected; this was more evident in the crossbreds. Factors for extending incomplete lactations derived from these data agreed reasonably well with other factors in general use, except at 30, 60 and 90 days.



At Tifton, Ga. selection within the Jersey breed is being tested as a means of developing cattle which produce high levels of milk under conditions existing in the lower Coastal Plains. The sires for this project are being selected from artificial breeding throughout the country with emphasis on low fat test and high levels of milk, and the mating plan has been initiated. Seven Jersey females were transferred from the Beltsville herd for the new project.

At Louisiana selection within the Holstein breed is being explored. Semen of 12 Holstein bulls has been obtained from bull studs throughout the country and matings have begun.

(b) Physiological characteristics of adaptability. Research studies of the physiological factors responsible for heat tolerance have been continued at Louisiana. In studies of monthly protein-bound-iodine values for Jerseys, Holsteins and Sindhi-Holstein F<sub>1</sub> crosses, marked seasonal effects were observed. The lowest values were observed during July and August and the highest during March and April.

Data on Jerseys and various combinations of crosses of Red Sindhi and Jersey, subjected at regular intervals to a standard hot atmosphere for 6 hours in a climatic control chamber at Jeanerette, La., have indicated an inverse relationship between age (up to 24 months) and reactions to the standard hot atmosphere. For both cows and heifers the degree of tolerance to the hot atmosphere was directly related to the amount of Red Sindhi blood in the animals. In the cow groups, within breed, level of production seemed to be directly related to the body temperature reactions. Dry cows tested on "cool" days reacted significantly different from those tested on "hot" days indicating a seasonal difference in the degree of acclimatization.

The reaction of heifers tested at Jeanerette was very much like those of similar breed groups exposed to the same treatment at Beltsville. On the other hand, the body temperature reactions of the Jeanerette F<sub>1</sub> half-bred cows (lactating and dry) were markedly less than the Beltsville F<sub>1</sub> half-breds. The respiratory reaction of the Jeanerette cows, both F<sub>1</sub> half-breds and purebred Jerseys, was less than comparable breed groups at Beltsville. These results suggested that some degree of acclimatization to a warmer environment is evident in the Jeanerette cows and that the crossbreds are more acclimated than the Jerseys at the same station.

(c) Influence of management practices on adaptability. Work at Louisiana showed that cooling lactating Holstein cows to 65 - 70° F. for 20 days during the summer did not have a significant influence on daily milk production, percent fat, percent SNF, forage dry matter consumption, digestibility of dry matter, protein-bound-iodine or metabolic heat production. Cooling the cows resulted in a marked reduction of body temperature, respiration rate and minute volume.



The effect of drinking water at 50° and 85° F. or adding 0.05% saccharine for lactating cows was studied. There were no differences between the treatments in milk production, milk composition or forage dry matter digestibility; however, the cooled water group consumed less water and slightly less forage while exhibiting lower body temperature and respiration rate than the other groups.

Research has been initiated at the Tifton, Ga. sta. with the objective of developing shelters and related facilities to protect livestock from summer and winter weather conditions that prevail in the Southeast. Limited facilities have been installed and preliminary studies conducted.

Further analysis of data from shade studies on nonlactating animals at Texas, with respect to the relative influences of air temperature, solar radiation, vapor pressure and wind velocity confirm previous findings that air temperature is the most important variable with respect to animal response in terms of rectal temperature, respiration rate and pulse rate. Solar radiation, vapor pressure and wind velocity followed in that order of relative influence. The data also showed that solar radiation loses much of its relative importance in producing animal responses when air temperatures are 90° F. or above. Studies on lactating cows with and without shade indicate that animals provided shade produced more milk but in regard to rectal temperature, respiration and pulse rate they were under as much stress as the animals in the sun.

(d) Climatological studies. As a means of arriving at a better understanding of the extent to which temperature, humidity and solar radiation vary in the Southern Region, data obtained from the U. S. Weather Bureau were analyzed. The results indicated that the portion of the day during the summer when conditions are above the "critical" level for the cow varied within the region. The mean monthly temperature for the month of July ranged from 78 to 83° F. for 20 stations yet the portion of the time the temperature was 80° F. or above ranged from 31 to 66%. The mean dew point ranged from 66 - 73° F. but the percent of time the temperature was 70° F. or above ranged from 0 to 96% indicating a wide range in humidity. The solar radiation mean for July ranged from 537 - 667 langley/cm<sup>2</sup>/day (215 - 267 BTU/sq.m./day) while the portion of time that the intensity was 700 ly/day or above ranged from 0 to 60%. A manuscript describing summer climatic patterns in the Southern Region along with a progress report on the relation of climate and livestock production are in preparation.

Plans: Two additional genetic methods for developing adaptability which are being investigated: systematic crossbreeding and development of a strain, from a crossbred foundation. Mating plans on all four methods will continue with less emphasis on the introduction of heat tolerance through crosses with Zebu cattle. Investigations of the physiological factors responsible for adaptability will be initiated, particularly those regarding the physiology of heat production. Efforts



will be made to expand the studies on nutritive and management factors which affect the productive response of dairy cattle in the South.

#### Publications

Factors Concerned in the Comparative Heat Tolerance of Jersey, Holstein and Red Sindhi-Holstein ( $F_1$ ) Cattle. J. E. Johnston, F. B. Hamblin and G. T. Schrader. J. An. Sci. 16:1105. 1957 (Abst.)

Effects of Hot Weather on Milk Production and Forage Consumption of Holstein Cows. J. E. Johnston, E. H. Stone, J. W. Smith, G. Schrader and J. B. Frye, Jr. J. Dairy Sci. 40:616. 1957. (Abst.)

Comparative Heat Tolerance of Jersey and Sindhi-Jersey Crossbred Cattle in Louisiana. M. W. Schein, R. E. McDowell, D. H. K. Lee and C. E. Hyde. J. Dairy Sci. 41:1405. 1957.

### 2. Breeding for Changes in Milk Composition

ARS-AH

Problem: To develop through breeding a milk which will supply the consumer with the most nutritious and palatable drink possible and the milk industry with a milk or milks giving maximum yields of products for which the demand is growing and a minimum of products which are in surplus supply.

Program: This is a continuing study involving basic genetic and chemical studies, in cooperation with 18 States, various breed associations, and EU, involving 1 professional Federal man-year annually.

Progress: Actual tests by the cooperating States are expected to get underway in the fall of 1958. A cooperative effort has been initiated to evaluate several rapid methods for estimating the protein content of milk.

Plans: The inter-State cooperative efforts on S-N-F will be initiated during the current year. Protein estimations will be included in the tests as soon as a rapid method has been determined as satisfactory for large scale sampling on individual cows. Studies on B-lactoglobulin will probably be complete in the current year.

### 3. Genetics of Feed Utilization in Dairy Cattle

ARS-AH

Problem: To improve the feed efficiency of dairy cattle with particular regard to forage utilization.

Program: A long-time study involving the determination of the inheritance of feed utilization and the application of genetic methods to improve this characteristic in cattle, including cooperative studies in four stations herds at the Montana and Tennessee Agr. Expt. Stas. and including the Holstein-Friesian and Jersey breeds, and involving less than one professional Federal man-years annually. The Tennessee study is contributing to the Southern Regional Dairy Cattle Breeding Project.



Progress: Efforts during the year have been confined to continuation of the trials at Beltsville and Tennessee and organization of the studies at Huntley and Bozeman, Montana.

Plans: In addition to continuation of studies recently initiated, it is anticipated that a cooperative study will be organized with the Utah Agr. Expt. Sta.

#### 4. Blood Antigen Studies

ARS-AH

Problem: To study within and between laboratory repeatabilities in the blood typing of dairy cattle, facilitate the standardization of reagents and procedures used and thus improve the usefulness of blood typing to dairy cattle breeders and increase confidence in the results obtained.

Program: This is a relatively short-time study involving cooperation with California, Wisconsin, Ohio and Wyoming Agr. Expt. Stas. and blood antigen laboratories in Canada, Norway, Sweden, Denmark and Holland. Trials are conducted twice yearly in which samples of the blood from 40 animals are sent to the cooperators for analysis. Results of the blood typing are returned to ARS for comparisons between and within laboratories.

Progress: Three trials have been conducted. In the most recent a total of 121 different routine reagents and 22 experimental reagents were used by 7 laboratories. Of these 19 of the routine reagents were common to all 7 laboratories. Preliminary analysis of results confirms the high specificity of the tests when carefully conducted and indicate that frequent errors of analysis are largely associated with particular laboratories.

Plans: After Trial IV is completed an analysis of the repeatability results will be made. On the basis of this analysis the future program will be evaluated.

#### 5. The Genetics of Mastitis Resistance

ARS-AH

Problem: To determine if resistance to mastitis can be improved through breeding and if it is related to level of production, milking rate and udder pendulouness.

Program: This research involves the determination of morphological types of bacteria, the number of leucocytes, and the presence or absence of ten of the major pathogens in monthly milk samples from 250 cows in three herds of the North Carolina Agr. Expt. Sta., involving less than 1 professional Federal man-year annually.

Progress: Estimates of the heritability of clinical mastitis were 0.71 from the paternal sister correlation, and 0.21 from the daughter-dam regression, and repeatability estimates of 0.35 and 0.40 were obtained. From these estimates and additional information on components of hereditary variance a value of 0.24 was arrived at as a reasonable value for the heritability of clinical mastitis. The inclusion of bacteriological data and leucocyte counts from monthly milk samples in the selection criteria resulted in only a 0-5% increase in efficiency of selection against clinical mastitis. The correlation between udder height and clinical mastitis was -0.27 ( $P < .01$ ) where herd and breed differences were removed, and -0.14 ( $P < .05$ ) where additional differences due to age were removed.



Results indicate that the incidence of mastitis is influenced by heredity and can be modified by selection for mastitis free animals. The relationship of udder height to mastitis incidence was not great enough to warrant consideration of udder height as a means of identifying cows with low susceptibility to the disease.

Plans: The cooperation on this work has been discontinued. A manuscript is being prepared regarding the initial study.

6. Genetics of Body Form and Internal Anatomy

ARS-AH

Problem: To determine the accuracy with which producing capacity and body form can be prejudged by examinations of body form of the growing heifer and to determine the possibility of developing a basis for selecting superior cows when records of production are not available.

Program: This is a long-time study involving estimations of the basic relationships of components of body form and internal anatomy with each other and with production as well as evaluations of selection by means of these characteristics, in cooperation with 20 State agr. expt. stas. It is part of the North Central and Southern Regional Dairy Cattle Breeding Projects, involving 2 professional Federal man-years annually.

Progress: To throw light on some of the theories and suppositions which have long been incorporated in the teaching of dairy cattle type the size of a number of the internal organs was studied in relation to several measurements of external body form for nearly 200 cows in each of the Holstein and Jersey breeds slaughtered for anatomical study at Beltsville. Wedge shape (the ratio of depth of paunch to depth of fore chest) was found to be positively correlated at a highly significant level with weights of lungs, kidneys, stomachs and liver; with length of intestines; and with milk production in Holsteins. The highly significant correlations ranged from .40 for intestine length to .19 for milk production. In Jerseys highly significant correlations with wedge shape were found to exist for weights of kidneys, stomachs and liver and for intestine length but not for milk production. These correlations ranged from .39 for stomach weight to .20 for weight of liver. Wedge shape was not correlated with heart weight in Holsteins and only moderately so in Jerseys. In both breeds the cows having paunch depths that materially exceeded chest depths had the larger abdominal organs.

Legginess, the proportion of the total height below the lower extremity of the fore chest, was found in Holsteins to be negatively correlated with weights of heart, lungs, kidneys, stomachs and liver; with length of intestines; and with milk production. All correlations were either significant or highly significant and range from -.30 for heart weight to -.17 for milk production. In Jerseys five of the seven correlations were negative but only the one for heart weight was significant. The correlation of both legginess and wedge shape with production were not large enough to indicate usefulness of either as a criterion for selection of cows.



Studies on the relationships of stomach weights and length of intestinal tract were carried out on 21 or more body measurements in addition to wedge shape and legginess. Only the ten items of body form having the highest correlations are discussed. The high ten correlations of body measurements with stomach weight ranged from .48 to .33 for Holsteins and from .40 to .26 for Jerseys. Nine of the ten in each breed were for measurements of the rear chest (mid barrel), body lengths, paunch dimensions. Head length appeared among the highest ten (eighth for Holstein and fifth for Jerseys).

All of the ten highest correlations between body measurements and intestine length were highly significant in both breeds. Measurements of the rear chest, body length, paunch accounted for 7 of the 10 in each breed. Head length was fourth highest for Holsteins but was not among the highest 10 correlations for Jerseys.

Progress has been made by a regional committee in the analysis of the body measurement data. Emphasis has been placed on studies of 697 Holsteins for which complete body measurements, production records of the individuals and production records of their dams were available. Body measurements were recorded at 6 and 12 months of age and 3 months after first calving. Five body measurements (height at withers, depth and circumference of chest, lengths from withers to hips and from hips to pinbones) were included. Combining heart girth at 6 and 12 months gave a multiple correlation of .17 for milk and provided a predictive value for milk production 20% higher than that of the dam's milk production alone. Combining heart girth at 6 months with dam's milk record gave a correlation of .20. Heart girth at 12 months combined with dam's milk record gave a correlation of .22. It appears that some body measurements in the young heifer may be helpful in evaluating potential milk producing capacity.

Regional analyses of various portions of the palpation and production data are being carried on by a committee. A manuscript covering the results obtained is nearing completion. It appears that data on the weight of the calf, together with the components of palpation, may be utilized to at least double the value of the dam's record as a basis for predicting producing capacity. The results indicate also that the information obtained by palpation at 5 months of age is approximately half as accurate as the animal's own first record as a basis for culling or selection.

Plans: Attention will be devoted to further analysis studies of the interrelation of individual body measurements. An analysis of available data on body contours will be started. Manuscripts will be prepared on the inter-regional analyses of body measurement and udder palpation data. The continuation of data collection will be reviewed in the light of completed analyses.



7. Minimizing Environmental Influences on Production Records and Sire Provings

ARS-AH

Problem: To increase the accuracy of selection by improving estimates of genetic differences in production though minimizing important environmental influences.

Program: This is a continuing study involving the identification of the major influences, estimation of their effects and evaluating methods of minimizing these effects, in cooperation the the Michigan and Wisconsin Agr. Expt. Stas., involving less than 1 professional Federal man-year annually.

Progress: In Wisconsin 44 standard DHIA herds in 11 southern counties have been used. Production, environmental and other data essential for the computation of lactation and herd totals were reported monthly by 26 DHIA supervisors. A minimum of 4 farm visits were made to each herd for further evaluation of breeding, feeding and management practices. A total of 2,378 lactation records were tabulated during a 3-year period, November 1953 to December 1956. In order to estimate the specific effect measured environmental influences had on butterfat production, 1,167 records having complete production and environmental information were analyzed. Butterfat production was found to be significantly influenced by the pounds of TDN fed daily, the length of the preceding dry period, the number of days carried calf while milking, the calving interval, herd size, and herd ratings regarding summer feeding, housing, disease and injury, milking and feeding practices. The variables studied accounted for 20% of the variation of records within herds and 27% of the variation of records both within and between herds. TDN fed daily was the most important of the influences studied. Preceding dry period, days carried calf and calving interval each accounted for less than 3% of the variation. Much of the variation in butterfat yield associated with season of calving was found attributable to the amount of TDN fed, the length of previous dry period, the calving interval and herd size. The various herd management ratings were found to be closely correlated with each other, indicating that either a combination of the ratings or the use of only one of them would be desirable.

Plans: Experience suggests further study on collecting information on management practices as recorded by DHIA fieldmen in order to insure sufficient accuracy for use.

8. Genetic Methods in Dairy Cattle Improvement

ARS-AH

Problem: To evaluate the application in dairy cattle improvement of genetic methods suggested by studies with laboratory animals and other organisms.

Program: These are continuing studies involving the application of known genetic concepts to dairy cattle improvement, consisting of live animal experiments in 28 herds representing five breeds and located in 8 States, and involving working relationships with the various State



agr. expt. stas. and in cooperation with the National Association of Artificial Breeders. Five of the studies are contributory to the North Central Regional Dairy Cattle Breeding Project. This work involves 10 professional Federal man-years annually.

Progress: Wisconsin has continued the development of six inbred lines of Holstein-Friesian cattle, crosses between the lines and maintenance of controls. First lactation butterfat records of first generation inbred ( $F_x .29$ ) and outbred progeny showed that there were differences in production among years, among lines and that the lines reacted differently to the influence of inbreeding. One line in which the inbreeding coefficient averaged .29 showed a reduction of 40% in butterfat production. In another line, for which the average inbreeding was .25, the butterfat production of the inbreds was only 4.5% less than the production of the outbreds. A corollary study regarding the repeatability of type classification scores has been in progress since 1950. Each animal in the herd over 6 months of age has been classified twice yearly. An analysis of this study showed that there was more variation in the rating given the same animal if that animal was a heifer than in the ratings given an animal after she had freshened. On the other hand the differences between animals were greater for those which had freshened than for the heifers. Final rating repeatabilities were generally higher than those of the breakdown ratings. There was little evidence that either winter or summer ratings were consistently higher in repeatability.

A similar study was conducted in Ohio. Data involving approximately 1,100 animals which were evaluated for type at 3 months, 6 months, 12 months and 3 months after calving indicated that in general there was a rather low association between nearly all type categories and milk production. The highest association appeared to be in regard to size, shape of udder, and dairy character. The heritability of type characteristics of the sire and those of his daughters appeared to be low. The usefulness of type scoring of the dam as a means of predicting the type of the daughter also appeared low, particularly in regard to udder characteristics.

A study was conducted on the influence of the sex, line of breeding and horn of uterus on variation in weight at birth and length of gestation. Results showed that the sex of the calf and the line of breeding significantly influenced variation in the two characteristics. On the other hand the horn of pregnancy appeared to have no significant influence.

In the Illinois Gurnsey x Holstein crossbreeding project, findings on calf mortality showed that of the 128 purebreds born, 14.8% were born dead or died before they were able to produce a calf. Of the 127 crossbred and crisscross progeny born, 5.5% were born dead or died before calving. These differences in death losses were significant. It was found that the system of mating (purebreeding or crossbreeding) did not have a significant effect on withers height at any age and had a significant effect on body weight at 18 and 24 months of age only. Since the heritability of these two characteristics is relatively high,



it would not be expected that the nonadditive genetic effects of system of mating would comprise a major portion of the variability. During the year, work on a chemical analysis consisted of determining monthly lactose, casein, whey proteins, crude proteins and fat in the milk of the individual cows.

The Indiana project involves a rotational cross of Red Dane, Red Poll and Milking Shorthorn cattle and maintaining purebred contemporaries. It has been observed that the purebred calves are more subject to disease and death loss than the crossbred animals. The percent loss in the purebred animals has been 24.9%, and in the two- and three-breed crosses only 17.7%. Preliminary work has begun on the analysis of feed efficiency data on steers. The ranking of breeding groups on efficiency of gain is: Three-breed crossbred, Red Dane X Milking Shorthorn, Red Poll X Milking Shorthorn, Red Dane X Red Poll, Milking Shorthorn, Red Dane and Red Poll. The ranking of the groups on preliminary milk production is: Red Dane X Milking Shorthorn, Red Dane, Milking Shorthorn, three-breed crossbreds Red Dane X Red Poll, Red Poll X Milking Shorthorn, Red Poll.

The Beltsville crossbreeding project has been revised to explore additional theoretical and practical aspects of the problem. In this program a three-breed rotational system will be employed using Ayrshires, Brown Swiss and Holsteins. The foundation herd consists of 40 females of each breed. In order to obtain as much genetic variation as possible in the foundation group, one-third of the heifers were purchased from each of three geographical areas of the U. S. These animals will be mated to progeny tested sires selected at random from artificial breeding associations throughout the country. Comparisons in production, growth and reproduction characteristics will be made between crossbred and purebred paternal half-sibs.

The revised research with the purebred Holstein herd at Beltsville has been initiated. The study will estimate the effect of parental relationships on the breeding value of dairy cattle. Three levels of parental relationship will be tested. For one-third of the existing herd, proved sires are being selected from the Holstein breed which are unrelated to the herd. For the second group proved sires are being used which were bred from the herd and proved elsewhere. In the third group proved sires are being selected which are of a different breed than Holstein. Sires are being selected which appear to have the most promise of increasing the milk, butterfat and solids-not-fat yield of the existing cattle. Cows resulting from these matings will be evaluated for their production and other economic characteristics. The genetic merit of the sons resulting from the matings with three types of parental relationships will be compared by the use of semen services in cooperating herds.

Plans: Mating plans will continue on all studies. Negotiations are in progress to integrate the Ohio and Minnesota studies into a project which will test the extent to which specific and general combining



ability are of importance in dairy cattle breeding. Analysis of the proved sire research with Holsteins and Jerseys and with Holsteins in Montana will be completed. Analyses will also be carried out on the use of sons of proved sires in cooperating herds working with the Beltsville and Montana studies.

#### Publications

Repeatability of Teat Measurements in Dairy Cattle at Various Ages.  
D. O. Richardson, T. M. Ludwick, H. E. Rickard, and W. M. Etgen.  
J. Dairy Sci. 40:630-631. 1957.

### 9. Study and Analysis of DHIA Feed and Production Records

ARS-AH

Problem: Dairymen need information on feeding and herd management practices that will result in maximum efficiency in the production of milk.

Program: A continuing long-term program conducted in cooperation with the 49 States and 2 Territories to obtain and analyze complete records on mass population of dairy cattle under field conditions, and involving less than 1 professional Federal man-year.

Progress: Data obtained from approximately 1,500,000 cows in about 40,000 herds were analyzed on a county, State and national basis. The success of the program is evidenced by the fact that in 1957 the average production of DHIA cows reach<sup>ed</sup> an all-time peak with an average of 9,894 lb. milk and 389 lb. butterfat.

Four electronic data computing centers are now using the IBM-650 automated procedures and are processing DHIA records from approximately 24 States. Other computing centers are developing similar procedures for obtaining more complete DHIA records.

Studies were continued on DHIA supervisors' methods and techniques of obtaining and reporting feed data to improve and refine the procedures for obtaining feed input data on a net energy basis.

Plans: Work will be continued to assist State and regional computing centers to develop procedures for obtaining and analyzing more complete DHIA records.

#### Publications:

U. S. summaries and studies of DHIA records are published in the monthly Dairy-Herd-Improvement Letter

### 10. The Organization and Operation of DHIA and AB Organizations

ARS-AH

Problem: To develop and maintain organizational and operational procedures of dairy-herd-improvement associations and artificial breeding organizations that have a direct bearing on the over-all effectiveness of the National Cooperative Dairy Herd Improvement program.



Program: Continuous studies are conducted, in cooperation with the American Dairy Science Association's Records and Breeding Committees, to determine those organizational and operational procedures that contribute to the over-all dairy-herd-improvement program. Effective procedures are recommended for general adoption. This work involves less than 1 professional Federal man-year annually.

Progress: It has been repeatedly demonstrated that dairymen who keep feed and production records on their cows and herds are in a position to improve the efficiency of their herds, produce milk at lower costs and increase their net returns. Continuous effort is exerted to include more dairy herds in one of the three record keeping plans of DHIA: (a) Standard DHIA, (b) Owner-Sampler, and (c) Weigh-a-Day-a-Month.

During the year, the number of cows included in these record plans increased 10 percent, and at present more than 2,100,000 cows are enrolled in the DHIA. On January 1, 1958, more than 900,000 dairy herds were enrolled in the artificial-breeding program. During 1957, 6,055,982 cows, or approximately 27% of the cows and heifers of the nation were bred artificially. Through the artificial-breeding program the better sires discovered and proved in DHIA herds are used in AB studs where their hereditary influence is widely disseminated throughout the dairy cow population.

Plans: Work will continue to determine those operational practices which effectively contribute to the over-all herd improvement program. Studies will be continued to develop summaries and analyses of sire data needed to effectively guide the artificial-breeding program in each State or area. During January 1959, plans will be carried out for a nationwide campaign to increase the number of herds and cows included in one of the record keeping plans.

#### Publications

Summaries of the status of the National Cooperative Dairy Herd Improvement program and the Artificial Breeding organizations are published in the February and March issues of the Dairy Herd Improvement Letter.

#### 11. Proving Dairy Sires in DHIA Herds

ARS-AH

Problem: Provide analyzed data to indicate the genetic worth of dairy sires that individual dairymen and AB studs may select sires with increased assurance that sires selected will improve the inherent producing ability of the herds in which they are used.

Program: A continuing long-term program to obtain complete DHIA records on the individual cows in the approximately 40,000 herds on DHIA test in the 49 States and 2 Territories to maintain a central genealogical and production record file to compile and analyze proved-sire data. Proved-sire records are furnished to herd owners. Individual proved sire record summaries are distributed widely among dairymen and dairy leaders. This work involves less than 1 professional Federal man-year annually.



Continuous research studies are made to improve the data and methods and techniques of analysis to develop proved-sire records that more reliably indicate the genetic worth of individual sires.

Progress: During 1957, a total of 5,265 sires were proved. These sires had a total of 44,028 daughters. The daughters, on the average, produced 10,200 pounds of milk and 420 pounds of butterfat.

During the year, plans, based on research to date, were completed for an improved type of proved-sire record that can be compiled and analyzed when electronic data processing equipment is used to handle proved-sire data. In addition to the usual dam-and-daughter comparisons, the proved-sire records will include concurrent herd averages, unrelated stablemate or contemporary averages and information on the feed input of the daughters of the sire and their dams. The records will also include summaries to indicate the performance of each sire when used for natural matings and when used in AB studs.

Work was continued on the development of electronic data processing procedures using IBM-705 tape equipment for handling and processing DHIA records and complete automation for compiling proved-sire records. This work is progressing as rapidly as available funds will permit.

Plans: Work will be continued to complete electronic data processing procedures for handling and processing DHIA records and the compilation of proved-sire records.

Comprehensive research studies requiring electronic data processing equipment to handle the computations involved will be developed so that exhaustive analyses may be made of the complex factors influencing production levels and to develop methods and techniques of treating the data so as to improve the reliability of proved-sire records.

### Publications

Summaries of DHIA proved-sire records are published each month in the National Cooperative Dairy-Herd-Improvement Letter which is widely distributed among dairymen and dairy leaders through the country.

## E. DISEASES AND PARASITES

### 1. Leptospirosis

ARS-ADP

Problem: Develop new and improve diagnostic procedures, and methods of prevention and control.

Program: A continuing long-term program of basic studies on nutritional requirements, antigenicity, pathogenicity, and immunogenicity of Leptospira pomona, methods of transmission and spread, and response of the host to infection, involving approximately 3 professional Federal man-years annually.



Progress: A modification of Stuart's liquid medium was superior to all others for the study of *Leptospira* which have been adapted to laboratory environment. Seven percent rabbit sera is the optimum level for the propagation of *L. pomona*. A starting medium having a pH of 7.4 produced optimum growth. Incubation temperatures of 28.5 - 29° C. resulted in maximal cell crops at an optimum growth rate. A volume of medium which allows optimum aeration to take place also is necessary in obtaining maximum growth.

The most satisfactory method of primary isolation has been the injection of suspected excretions or secretions into guinea pigs with subsequent culture of heart blood in Chang's semisolid medium containing 10% defibrinated horse blood serum.

Comparative work with two high density nephelos standards clearly shows a bacterial standard consisting of a 1:100 dilution of Brucella tube antigen to be reproduceable, simple to use, and available to any laboratory in this country for measuring growth of *Leptospira*. The instrument of choice is the Coleman #7 nephelometer which measures reflected light. Measurement of turbidity by light transmission instruments such as the Beckman DU, Bausch & Lomb Spectronic 20 and Klett Colorimeter agree quite closely with one another. *Leptospira* dry weights reflect the process of protoplasmic synthesis and also correlate well with optical density measurements.

In an effort to identify the factor or factors in rabbit serum responsible for promoting growth of *Leptospira*, characterization of the serum showed that there was no correlation between concentrations of carbohydrates, protein nitrogen, albumin, and globulins and their utilizations. Moreover, heating of serum up to 70° C for 30 minutes does not alter the growth of *Leptospira* significantly.

Study on natural outbreaks of leptospirosis in several herds strongly indicates that bovine leptospirosis is of a self-limiting nature, and that vaccination at the time clinical symptoms cease or shortly thereafter does not alter the course of the disease. In these herds the disease has shown little or no difference in spread of infection in either vaccinated or nonvaccinated animals. It has been demonstrated that the spread of infection will decrease sharply without intervention. Most reacting animals tend to retain titers for a prolonged time.

Plans: Work will continue to develop a rapid and reliable method of isolating *Leptospira* from the host, a diagnostic test, persistence of *Leptospira* in the known hosts, length of time these hosts expel the infectious agents, and methods of transmission.

## 2. Mastitis

ARS-ADP

Problem: Isolation and characterization of the inhibitory and stimulatory factors in milk which influence growth and acid production by *Streptococcus agalactiae*.



Program: This is part of a long-term program to determine the basic factors responsible for variations in the susceptibility of udders to infection and the development of clinical mastitis, and involves approximately 2 professional Federal man-years annually.

Progress: Preliminary work has indicated that separation of the inhibitory and stimulatory factors cannot be obtained by dialysis or certain ultra-filtration methods. Separation of the two factors was successful when the Spinco Model CP continuous flow electrophoresis apparatus was used, as 3 out of 26 fractions collected in one experiment contained only the inhibitory factor. Results of tests with these fractions indicate that, in the absence of the stimulatory factor, the inhibitory factor in milk reaches its maximum potential for inhibiting acid production by Str. agalactiae. Acid production can be considered as a measure of growth of the organism.

Plans: Work will continue on the isolation and characterization of the inhibitory and stimulatory factors in milk and their relationship to mechanism of infection of the udder.

#### Publications

A Study of the Necrotizing Action of Staphylococcic Alpha Toxin.  
R. W. Brown and R. K. Scherer. Amer. Jour. Vet. Res. 19, 354-362, 1958.

### 3. Vibriosis

ARS-ADP

Problem: Development of specific diagnostic tests, and methods of preservation, control, and elimination of infection.

Program: A long-term program involving basic research on the causative organism, immunologic response of the host, and pathogenesis of the disease, as well as application of new findings to adequately control vibriosis, carried on at Beltsville and in cooperation with New York State Veterinary College, Ithaca, N. Y., and involving approximately 2 professional Federal man-years annually.

Progress: Cultural recovery of Vibrio fetus from contaminated material is erratic. Attempts to find any bacteriostatic agent for addition to culture media that will inhibit Proteus and molds without also inhibiting V. fetus have been unsuccessful. Malucidin, a new antibiotic, also proved ineffective in controlling Proteus. The use of high titer Proteus antiserum did not prove successful to remove the bacteria from suspensions containing V. fetus. Florent blood agar plates proved most useful for the isolation of V. fetus. Semen appears more useful for the isolation of V. fetus than preputial washings. Catalase activity still is the best test to differentiate pathogenic and nonpathogenic Vibrio. This blood test has little value in the diagnosis of vibriosis.



Variants from the original smooth colonial forms of V. fetus and non-pathogenic Vibrio isolated from the reproductive tracts of cattle occurred under unfavorable conditions such as ageing of cultures, excess of CO<sub>2</sub> or O<sub>2</sub>, dyes in media, abnormal moisture content of media, and by a change to different medium.

The exposure of pregnant cows to Vibrio fetus by various routes, which included feeding culture suspension or macerated aborted fetal material, of conjunctival inoculation, and intravenous injection with culture suspension, as well as exposure by breeding to an infected bull apparently immunizes females to the extent that they will have a satisfactory conception rate when bred to an infected bull for a following calf crop. Although previous infection with V. fetus produced sufficient immunity to prevent an unsatisfactory conception rate in females bred to an infected bull for the following calf crop, it did not prevent re-infection from becoming established in their vaginas for various periods of time. Some animals carried vaginal infection throughout gestation, and for a few days thereafter. The agglutinin response of the vagina did not appear to be related either to the rate of conception or to the establishment of vaginal infection in these cattle when bred subsequently to an infected bull. In genital infection of cattle, the virulence of V. fetus was directly related to the time required for conception; whereas, it was unrelated to time required for spontaneous recovery.

The site of localization of V. fetus infection may not always be confined to the reproductive tract as shown in two cows in which gall bladder infection resulted from intravenous exposure.

Plans: Emphasis will be on determining the exact locations of Vibrio and length of time they remain in the reproductive tract of heifers and cows. Develop new and improve cultural and serologic procedures which will provide an accurate means of identifying infected animals.

#### Publications

A Comparison of the Effect of Catalase-Positive and Catalase-Negative Vibrio on the Fertility of Cattle. A. H. Frank, J. H. Bryner, and B. Caruthers. Am. Jour. Vet. Res. 19. 1958.

Breeding Difficulties in Dairy Cattle, Their Causes and Prevention. A. H. Frank co-author with 6 others. Northeast Regional Pub. No. 32, Bul. 934. 1957. Published by N.Y. Agr. Expt. Sta., Ithaca, N. Y.

#### 4. Brucellosis

ARS-ADP

Problem: Develop fundamental information that can be used to improve diagnostic procedures, to better understand the epidemiology of the disease, and to improve methods of control.

Program: A long-term program of basic research on biochemical and physical properties of Brucella, the response of the host to exposure to Brucella, and the effect of immunological and therapeutic agents on the course of the disease, carried out at Beltsville and in cooperation



with the California, Minnesota, Wisconsin, and Maryland Agri. Expt. Stas. and involving approximately 2 professional Federal man-years annually.

Progress: Post-vaccinal titers receded below the 1:50 level at 79, 94, and 85 days in the respective groups of calves that had been vaccinated at four, six, or eight months of age. When these heifers were pregnant they were exposed to virulent Brucella abortus. About thirty days after exposure, both vaccinated and nonvaccinated cattle showed an increase in titer of two or more dilutions to the standard seroagglutination test.

Sixty days after exposure two distinct titer patterns were apparent. The first was that the titers of the nonvaccinated and nonresistant vaccinated cattle continued to rise and remained high as infection progressed. The second pattern was that observed in the majority of resistant vaccinated cattle. Their titers did not rise above the suspect or low reactor level. The titers of the animals that resisted infection receded to or near the pre-exposure levels. There was no apparent correlation between maximum post-vaccinal titers and subsequent, maximum post-exposure titers. Post-exposure responses of animals that showed post-vaccinal bacteremia did not differ from those that showed no bacteremia.

The heat inactivation test was investigated as a means of differentiating specific from nonspecific Brucella reactions, and for detecting early infection. Pre-exposure heat inactivation tests did not reveal the presence of specific Brucella agglutinins; whereas, post-exposure heat inactivation tests did reveal their presence in most animals. Specific agglutinins disappeared in approximately 60 days after exposure of animals that resisted infection. The test was no more critical in identifying early infection than the standard seroagglutination test.

Another test involving acidified antigen was used for differentiating specific from nonspecific Brucella reactions. All sera were tested with acidified antigens having a pH of 3.0, 3.5, or 4.0. Most of the resistant animals continued to show positive reactions with pH 4.0 antigen which is an indication that the nonspecific agglutinins were not inhibited. Acidified antigens with a pH 3.0 have an opposite effect in that they inhibited some specific as well as nonspecific agglutinins. Acidified antigens with a pH 3.5 gave a more accurate indication of actual infection than the other two.

The differential tests were also conducted on sera from another group of 97 reactor animals whose milk was examined bacteriologically. Brucella organisms were isolated from 37. Lowering the pH of the antigen-serum mixture to 3.5 did not inhibit the agglutinin reactions in any of their sera; whereas, when the pH of the mixture was reduced to 3.0, the agglutinins were inhibited in three. The heat inactivation test also inhibited agglutinins in four. Of the sixty reactors from which Brucella was not isolated, the seroagglutinins were inhibited in 17 with an antigen of pH 3.5, in 26 with an antigen of



pH 3.0, and in 24 with the heat inactivation test. There was complete agreement between the heat inactivation tests and the Meinecke tests, the latter being a test used currently in Germany.

The second more comprehensive study of the whey plate test confirmed more conclusively than before that it is not reliable as an official diagnostic test under the conditions present in Minnesota. This is emphasized by isolation of *Brucella* from 35% of whey negative, blood positive cattle. Studies on nonspecific *Brucella* agglutinins have shown that this substance is a unique serum protein, differing from specific antibody when exposed to various physical and chemical agents to an extent which can only be accounted for by distinct differences in molecular species. Nonspecific *Brucella* agglutinin does not arise from *Brucella* infection, as indicated by the extensive bacteriological studies which were conducted.

A field survey covering 10 counties in Wisconsin has shown that a significant number of animals shedding *B. abortus* in the milk can be found in herds which have a 2+ reaction on the milk ring test. Thus it would not be feasible to eliminate herds with the 2+ ring test reaction from consideration for serum agglutination tests. Another survey of two counties in which complete area-wide blood tests were conducted showed that the milk ring test applied semi-annually was sufficient for certification and re-certification of such areas, without the necessity of periodic area-wide blood serum agglutination tests.

The Cameron whey test missed a significant number of reactors, which were properly identified by the blood agglutination test and which were positive on bacteriological examination.

The acidified plate antigen test conducted at pH 3.8 or higher did not inhibit the blood serum agglutination reactions of any reactors or suspects which were positive on bacteriological examination, whereas a pH of 3.5 or lower did. These findings further clarify the limits of accuracy and sensitivity of tests with the acidified plate antigen.

At least four antigens have been shown to be present in soluble extracts of *B. abortus* by special techniques. Two of these are associated with the bacterial cell surface. Fluorescent antibody techniques have been used to demonstrate *B. abortus* cells growing in cultures of monocytes from normal guinea pigs.

Evidence for the presence of the cytochrome system in cells of *B. abortus* and *B. suis* has been developed. Preliminary evidence indicates that differences in the rate of metabolism of glutamic acid between virulent and avirulent strains of *B. abortus* may be attributable to differences in permeability of the bacterial cells to glutamate. Differences in the metabolism of lactic acid between strains of *B. abortus* of low and high virulence have been found. This phenomenon could explain why the intra-cellular growth of virulent strains of *Brucella* is not inhibited while the growth of avirulent strains is inhibited.



Further work suggests that whey reactions at 1 and 2 titers should be considered only as suspects and that titers of 3 and over be considered positive. Suspects on the whey test should be blood tested and branded if reacting to the latter. A whey testing program in Marin County, Calif. reduced herd infection from 30 to 6% and the animal infection from 1.06 to 0.13% during a 15-month trial period. The whey test has been discontinued in the county because 6% of the herd continued to react to the milk ring test. This occurred in spite of removing all lactating cattle that showed any reaction to the whey test.

Measurement of protective quality of bovine sera in Brucella-infected embryonating eggs does not appear to be an accurate method of determining immunity in cattle. The protective index of sera from vaccinated and non-vaccinated cattle located in both infected and non-infected herds in Maryland has not been significantly different. A comparison of ether-killed, egg-adapted, streptomycin-dependent, and Strain 19 vaccines showed that none were equal or superior to Strain 19 in their ability to produce immunity, and only one produced a less persistent agglutinin response.

A study of the effect of virulent B. abortus exposure on serum proteins of vaccinated and nonvaccinated pregnant cattle showed that the amount of gamma globulin was greater or equal to the amount of albumin in sera of infected cattle that aborted, whereas there was no change in the serum proteins of cattle that resisted infection. The percentage of gamma globulin began to exceed that of albumin at 11 to 17 weeks after exposure. Excessive gamma globulin persisted from 2 to 15 weeks and then both serum fractions returned to normal.

Plans: Work will be completed on the milk whey test during the coming year. Studies will be continued on the three main phases of the present program.

#### Publications

Comparative Efficacy of Trypticase-Soy and Veal Infusion Broths for Isolating Brucella abortus from the Blood of Cattle. C. A. Manthei, T. E. Amerault and E. R. Goode. Bull. Wld. Hlth. Org., 19. 1958.

Joint FAO/WHO Expert Committee on Brucellosis. Third Report. C. A. Manthei, and 9 other members of the FAO/WHO Committee. Wld. Hlth. Org. Techn. Rep. Ser., 148. 1958.

A Study of the Whey Plate Agglutination Test for Brucellosis. M. H. Roepke, F. C. Stiles, Jr., T. G. White, and F. C. Driver. J. AVMA 131. Aug. 1957.

Further Studies on the Whey Plate Test for Brucellosis. F. C. Stiles, M. H. Roepke, F. C. Driver and R. K. Anderson. J. AVMA 132. Jan. 1958.



Publications (continued)

The Efficacy of the Brucellosis Ring Test in Certifying Areas. M. H. Roepke, F. C. Stiles and F. C. Driver. J. A.V.M.A., 133, 93-96. July 1958.

A Summary of the Studies in Minnesota on the Whey Plate Test for the Diagnosis of Bovine Brucellosis. M. H. Roepke, F. C. Stiles, Jr., and F. C. Driver. Proc. 61st Ann. Meet., U.S.L.S.A., 118-126, 1957.

Immunochemical Studies of Phenol Extracts of Brucella abortus. L. E. Schneider and D. T. Berman. Bact. Proc. 76. 1958.

5. Tuberculosis

ARS-ADP

Problem: Develop more specific tests for the diagnosis of bovine tuberculosis.

Program: Continuous program involving basic studies of antigenic properties of the three types of tuberculosis organisms, and the antibody response of infected animals carried out at the Federal field station at Auburn, Ala., and involving approximately 1 professional Federal man-year annually.

Progress: Of 30 tuberculin reactors that showed lesions on postmortem, 46.6% were suspicious or positive to the hemagglutination test and 50% were suspicious or positive to the hemolytic modification test. Of 120 tuberculin reactors that did not show visible lesions on postmortem, 43.3% were suspicious or positive to the hemagglutination test and 50% were suspicious or positive to the hemolytic modification test.

The best anigens were those prepared from extracts of the organisms of Mycobacterium tuberculosis var. hominis and Mycobacterium paratuberculosis that were grown in culture medium, dried, and ground in a ball mill.

Plans: The approach to developing diagnostic tests that are more specific than present ones will be a continued study of the antigenic structure of the antibody response of the host to tuberculosis organisms.

Publications

Methods of Injecting Tuberculin. A. B. Larsen, L. A. Baisden, R. S. Merkal, and M. J. Morris. Amer. Jour. Vet. Res., 18:546-549. 1957.

6. Paratuberculosis

ARS-ADP

Problem: Develop new facts which can be used to improve detection, prevention and control of infection.

Program: A long-term program of basic studies on the characteristics of Mycobacterium paratuberculosis, antibody and immunologic response of the host, and mechanism of infection carried out at the Federal field station at Auburn, Ala., and involving approximately 2 professional Federal man-years annually.

Progress: A herd of cattle infected with Johne's disease is tested three times a year and intestinal specimens are obtained from each animal slaughtered. During a period of 21 months, six intradermic tests, six hemagglutination tests, and three complement fixation tests have been conducted in a herd infected with Johne's disease. Approximately 10% of the cattle react to the intradermic test, 50% to the hemagglutination test at a titer of 1:32, and 60% to the complement-fixation test at a titer of 1:8. Twenty-six animals have been autopsied. Twelve were intradermic johnin reactors and 14 were not, but all were reactors to the hemagglutination test. Acid fast bacilli were found in the intestines of 9 intradermic reactors and of 5 non-reactors. Seven of the animals disposed of were showing clinical evidence of Johne's disease, but only 1 was a johnin reactor.

Serum samples submitted with intestinal specimens from ruminants suspected of Johne's disease have been tested by means of hemagglutination tests and the results compared with microscopic findings. Small acid-fast bacilli were demonstrated in about 30% of the specimens, while hemagglutinating antibodies were present in 94% of all sera. These results indicate that the hemagglutination test may not be an efficient test, if finding small acid-fast bacilli is used as a criteria of infection.

The proteins in the culture filtrate of Mycobacterium paratuberculosis were separated by fractional precipitation at various pH's and continuous flow paper electrophoresis in 5 fractions and work has begun on structural identification of one of these. Work has not progressed to the state of significant findings.

Plans: Continue to study the pathogenesis and spread of paratuberculosis in a naturally infected herd, and to apply experimental procedures for its control. Basic studies will be continued on determining the chemical composition of M. paratuberculosis to better understand its metabolism and antigenic properties.

#### Publications

Sensitization of Cattle Erythrocytes with Johnin PPD and Tuberculin PPD. R. S. Merkal and A. B. Larsen. Amer. Rev. Tuberc. and Pul. Dis. 77: 177-180. 1958.

The Chemical Constituents of Mycobacterium paratuberculosis. A. B. Larsen and R. S. Merkal. Amer. Rev. Tuberc. and Pul. Dis., 77: 712-715. 1958.



7. Vesicular Stomatitis of Dairy Cattle

ARS-ADP

Problem: To develop information and techniques to control and eradicate vesicular stomatitis.

Program: Continued studies of the replication, characteristics and hostrange of vesicular stomatitis virus, with special emphasis placed on survival of the virus, and mode of transmission carried on at Beltsville, and involving approximately 4 professional Federal man-years annually.

Progress: Vesicular stomatitis in the U. S. occurs in two forms, epizootic and enzootic. The epizootic form is seen as a rapidly spreading disease affecting thousands of cattle and horses over wide area. The enzootic form appears on the Coastal Plain in the Southeast each May or June and disappears each Fall. It usually is first observed in swine and later in cattle, horses, man, deer, raccoons, and other wild animals. In dairy cattle, it is often seen as an infection of the udder and teats, which rapidly spreads through an entire herd causing a severe mastitis.

Procedures for the isolation, laboratory diagnosis, and typing of the virus have been successfully developed. An epizootiological survey of the enzootic region has been initiated and indicates that the disease is vector-borne with a biological reservoir of infection.

Plans: Efforts will be made to isolate virus from experimentally infected animals, naturally infected animals, recuperated animals, and lower forms of animal life to determine the reservoir. Lower forms of life which are eaten by animals, as well as both internal and external parasites, especially those present during the time the disease is spreading, will be studied to determine their possible role as vectors.

Publications

Vesicular Stomatitis Immunization with Inactivated Vaccines of Chicken Embryo Origin. A. A. Holbrook and J. N. Geleta. Proc. 61st Ann. Meet. of the U.S.L.S.A. Nov. 1957.

Further Studies on Enzootic Vesicular Stomatitis. R. P. Hanson and L. Karstad. Proc. 61st Ann. Meet. of the U.S.L.S.A. Nov. 1957.

A Study of Vesicular Stomatitis in Man. W. C. Patterson, L. O. Mott, and E. W. Jenney. J. A.V.M.A. 133. 1958.

The Use of Chickens in the Differential Diagnosis of Vesicular Exanthema and Vesicular Stomatitis -- A Preliminary Report. A. A. Holbrook and W. C. Patterson. J. A.V.M.A. 131. 1957.



8. Food-and-Mouth Disease (FMD)

ARS-ADP

Problem: Develop fundamental information regarding foot-and-mouth disease, its presently recognized seven immunologically distinct types, and numerous subtypes, or variants, of the virus, with emphasis on diagnosis, prevention, control, and eradication.

Program: Basic and applied research will be carried out on a continuing basis at Plum Island, cooperating with institutes in Denmark, England, the Netherlands, or elsewhere as opportunities or needs develop. Research on FMD is an all-out effort toward solution of many complex problems, and involves approximately 39 professional Federal man-years annually.

Progress: Swine previously<sup>ly</sup> inoculated with FMDV were found to harbor virus in heart muscle, salivary glands, urine, and kidneys for at least 19 days post-inoculation. In limited trials, tissues tested at 40 days after inoculation did not yield virus. FMD antibody was detected for 145 days after inoculation using the agar-diffusion and neutralization techniques, while with the complement-fixation technique FMD antibody was not detected after 94 days.

In limited trials with cattle, virus-neutralizing properties of colostrum persisted at a rather high level 9 days following parturition; however, the complement-fixing antibodies disappeared earlier. Larger quantities of antibody were found in colostrum than in blood serum during the first three days follow parturition.

Through a series of experiments involving inoculation of guinea pigs in various ways, it has been found guinea pigs inoculated by intravenous or intracardial routes have shown the best antibody response and have maintained higher antibody levels for a longer period of time. It was also found that guinea pigs weighing between 500-1000 grams are preferable for production of FMD immune serum.

It was observed that adult female mice which were nursing young routinely succumbed following inoculation with FMDV while non-nursing females and other adult mice were not affected. These observations suggested that physiological stress of lactation may have bearing upon the degree of susceptibility to the virus. Tissues from these mice when examined microscopically show cellular changes in the thymus which are not seen in other mice so inoculated. Adult mice, (not including females nursing young), are normally not susceptible to field and most laboratory strains of FMDV; however, serum from such mice inoculated with FMDV were shown to contain neutralizing antibodies as early as three days postinoculation and for intervals as long as 84 days after inoculation. The antibody persisted at a high level throughout the observation period.

Attempts to adapt one strain of virus to birds and embryonating chicken eggs have been fruitless, but other strains will be studied. Attempts to alter the same strain of virus through 20 serial passages in suckling mice resulted in reduction of infectivity for cattle.



Study is being pursued to identify chemical compounds which will destroy the infectivity of FMDV, yet not alter its antigenic properties. One such compound, beta-propiolactone, has been tested. Virus so treated was usually non-infective and it did retain complement-fixation properties; however, animals receiving injections of virus treated with this chemical did not develop demonstrable antibodies in their serum, suggesting that virus so treated would not be useful in simulating antibody production in animals. It was determined that the ethylene oxide gas (ETO) is effective in inactivating the virus in the presence of moisture; however, virus in a dry state is not always completely inactivated. These studies are being continued to develop methods for assuring complete inactivation of the virus in any form. Virus treated with ETO gas, when inactivated, has not been shown to have complement-fixing or other antigenic properties.

Methods for propagation of FMDV on outgrowths of kidney cells from several species of animals were developed at this laboratory. These culture methods have been further developed to include methods for precise determination of concentration of virus in fluids and for isolation of virus from field specimens; all techniques have been standardized. This method of virus production has been further developed to a stage that culture flasks holding 1/2 liter of fluid are now used. As much as 60 liters of virus have been produced per week by this method.

Recent small-scale experiments on the growth of FMDV in suspensions of trypsin-dispersed steer and calf kidney cells have resulted in the production of virus with titers approximating that found in infected tongue epithelium from the bovine. Virus has also been propagated in suspension of cells removed from the viable layers of bovine tongue epithelium; and, although virus produced by this method is of slightly higher titer, the method does not appear as satisfactory due to difficulties associated with obtaining the cells.

A suitable line of transmissible cells has been induced to grow in suspensions of fluid and these cultures serve as cell generators from which a portion of the cells may be periodically harvested and used for virus production or assay. A total of 39 different cultures lines are being carried at the present time, although all are not considered to be true cell lines. A line of transmissible cells which will support the growth of FMDV has not yet been found.

An infectious particle has been identified in electron micrographs revealing large numbers of a uniformly sized 22 mu particle which is not present in micrographs of control preparations. This particle has been identified as the causative agent of FMD by relating counts to infectivity and by aggregation and hyperimmune serum of cattle. It has also been found that at least 2 particles possessing complement-fixing activity exist in FMD isolates, a larger particle and a small particle approximately 8 mu in diameter. Preparations have been made of each of these particles which have been found to possess different



chemical and physical properties. Progress includes determination of a sedimentation rate 145S for the infective particle. The sedimentation rate of the small complement-fixing particle has been determined to be approximately 13S.

It has been concluded that cellular activity is sensitive to heat, acid, and alkali since cells subjected to these treatments appear dead as judged by inability to produce color changes in culture fluids. Freezing and thawing apparently do not affect the cellular activity.

During the course of heat-inactivation experiments using tissue culture virus, heat resistant survivors in the virus population were recovered. These particles have been studied to determine any characteristics differing from the parent strain. It has been found that heat-resistant variants when subsequently passaged in tissue culture without re-exposure to heat revert toward the heat-sensitive characteristics but, apparently, never complete revision. The thermal-resistant variants have consistently reached their growth curve maximum several hours earlier than the wild strains. No differences have been noted between the infectiousness of wild and heat-resistant strains for mice, guinea pigs, cattle, or bovine kidney tissue cultures.

Plans: A long-term project involving fundamental chemical, cytologic, diagnostic, physical, microbiologic, and immunologic investigations, the results of any or all of which may be applicable in prevention and control of the disease.

#### Publications

Purification and Electron Microscopy of FMDV. H. L. Bachrach and S. S. Freese, Jr. Proc. Soc. Exp. Biol. & Med., 97: 659-665. 1958.

The Effects of Heat and Hemoglobin on the Serum Proteins of the Guinea Pig. G. T. Dimopoulos and O. N. Fellowes. Amer. Jour. Vet. Res. 19:230-232. 1958.

A. Plaque Assay for FMDV and Kinetics of Virus Reproduction. H. L. Bachrach, J. J. Callis, W. R. Hess, and R. E. Patty. Virology 4: 224-236. 1957.

Direct Complement-Fixation for Detection of FMD Antibody in Serums from Experimentally Infected Cattle. A. A. Marucci. Amer. J. Vet. Res. 18:785-791. 1957.

Heat-Inactivated VSV as Antigen in the Complement-Fixation Test. G. T. Dimopoulos, O. N. Fellowes, J. J. Callis, G. C. Poppensiek, J. Tessler, and W. R. Hess. Amer. J. Vet. Res. 18:688-690. 1957.

Inactivation of FMDV by Ethylene Oxide Gas. J. J. Callis, J. Tessler, O. N. Fellowes, and G. C. Poppensiek. Bact. Proc., 1957.

Proceedings of Symposium on Vesicular Diseases. PIADL, Sept. 1956, ARS 45-1.



Publications (continued)

The Vesicular Diseases. M. S. Shahan. Third Ann. Meet. British Carribbean Vet. Assn., Port-of-Spain, Trinidad, May 1958.

What Plum Island is Doing in Research on FMDV. G. C. Poppensiek. Amer. Vet. Conf., Cornell Univ. and Univ. of Pennsylvania, Jan. 1958.

FMD Vaccination. M. S. Shahan. OIE Meeting, Paris, Jan. 1958.

A Combined Gross and Subgross Method of Studying the Total Pathology of Lingual Mucosa of Cattle Infected with FMD. H. R. Seibold. Conf. of Res. Workers in Ani. Dis., Chicago, Dec. 1957.

Electron Micrography of FMDV Purified from Tissue Culture. S. S. Breese and H. L. Bachrach. Electron Microscope Soc. of Amer. Meet., Cambridge, Mass., Sept. 1957.

Pathology of FMD in Various Species of Animals. J. J. Callis, H. R. Seibold, and G. C. Poppensiek. AVMA Meet., Cleveland, Aug. 1957.

The Assay of FMDV by the Plaque Method. W. R. Hess, H. L. Bachrach, J. J. Callis, and R. E. Patty. AVMA Meet., Cleveland, Aug. 1957.

9. Laboratory Diagnosis of Exotic Diseases

ARS-ADP

Problem: Develop and maintain trained staff, materials, and techniques for diagnosis of such foreign diseases of animals as foot-and-mouth disease, rinderpest, contagious bovine pleuropneumonia, fowl plague, African swine fever, etc.

Program: A continuing long-term program involving application of known principles and materials and basic investigations directed toward development and improvement of diagnostic procedures, including maintenance of reference stocks of appropriate antigens, sera, etc., in Denmark, England, Holland, Kenya (East Africa), and at the Plum Island Animal Dis. Lab., involving approximately 8 professional Federal man-year annually.

Progress: Biological materials necessary for various diagnostic tests have been accumulated and staff has gained experience in propagation, cultivation, and identification of the causative organism of contagious bovine pleuropneumonia.

Plans: No further diagnostic investigations with contagious bovine pleuropneumonia are planned, pending accomplishment of similar competence in relation to other exotic diseases.

Publications

The Exotic Zoonoses. M. S. Shahan and J. Traum. Annals New York Acad. of Sci. 70:614-623. 1958.

10. Anaplasmosis of Cattle

ARS-ADP

Problem: To develop means for controlling and eventually eradicating anaplasmosis.

Program: A continuing study of the nature of the etiologic agent, study of immune mechanisms between the host and the etiological agent, its transmission by insects and ticks, diagnosis of the carrier animal, and effective means for control carried on at Beltsville, and at Kerrville, Tex., with assistance to the Territory of Hawaii and 14 State agri. expt. stas. and State Livestock Disease Control Agencies, involving 6 professional Federal man-years annually.

Progress: Tick vector studies have revealed that male ticks, (D. variabilis), remain infected for 35 days; however, females of the same species have consistently failed to transmit the infection to the next generation of seed ticks. Studies on pregnant cows indicate that intra-uterine infection of calves is most likely to occur when the dam is acutely infected during advanced pregnancy.

The cooperative experimental anaplasmosis eradication program in the Hawaiian Islands has achieved its objective. Of 72,000 animals tested this year, only one case of the disease was found. The test and slaughter method has been used. Three years ago the incidence was 3.5% in the dairy cattle.

Plans: To determine the duration of anaplasmosis infection in the Rocky Mountain wood tick, (D. andersoni). A field trial in Texas is underway to learn if anaplasmosis-free herds can be established by separation of negative offspring at weaning time from infected cows. Surveys are to be done to correlate transmission of the disease in nature with insect vectors and ticks in several geographic regions.

Publications

The Diagnosis of Anaplasmosis. D. W. Gates. T. O. Roby, and P. A. Maden. Western Veter. 38-44. 1958.

11. Bloat

ARS-ADP,  
AH & CH

Problem: To determine the causes and the methods of preventing the development of sickness and death of cattle from the eating of various green legumes.

Program: A continuing long-term program involving basic and applied research to learn the role played by cattle and by legumes when cattle bloat so as to determine means of preventing losses therefrom, carried on at Beltsville and in cooperation with State agri. expt. stas. and veterinary colleges in California, Maryland, Minnesota, Mississippi, New York, and Wisconsin, and involving approximately 5 professional Federal man-years annually.



Progress: Field trials are being conducted with farmer cooperators in California to assess the practicability of using animal and vegetable fats for bloat prevention under pasture conditions. Experimental work has shown as little as .06 lbs. per cow of animal fats or tallows prevented bloat for four hours and increased the daily consumption of alfalfa as much as 40%. One centimeter of vegetable oil sprayed on each pound of fresh green alfalfa also prevented bloat.

The effects of procaine penicillin feedings on the rumen microflora are being studied when animals have been on bloat-producing diets for 2, 8, 14, and 16 weeks. No demonstrable in vivo effect of feeding penicillin on the production or partition of volatile fatty acids was noted. It appears that there is no effect on the metabolic pathways utilized by the rumen microflora in the utilization of the feed constituents. It was observed that penicillin, Tween, Tide, Versene, Span, other antifoams, and turpentine markedly reduced the production of gas from feedstuff carbohydrates by washed suspensions of rumen bacteria. Certain carboxylic acids increased the rate of production of froth of samples of ruminal content. The feeding of fresh alfalfa resulted in increases of the non-protein nitrogen of natural froth liquor.

Extensive studies have been made on the nerves and muscles of the oesophagus and various structures associated with eructation and the nervous reflex control of rumen and reticulum motility and the location and characteristics of the receptors associated with eructation and movement of the rumen. The receptors in cattle governing the reticuloruminal rate are located to a major degree in the reticulum-cardia area and are either of tension or tractile type. Those in cattle governing secondary rumen contraction rate are located to an important extent in the posterior sacs of the rumen and are most likely pressure or tension receptors. Work indicates the principal cause of death from insufflation of the rumen is anoxia. Eructation produces a rapid change in the blood gases.

Results indicated that the predominant bacteria cultured, numbers of cellulolytic bacteria, pH or rumen contents, kinds and relative numbers of protozoa, and total anaerobic bacterial counts were not significantly different. The difference in anaerobic count between bloaters and non-bloaters approached significance. Counts of bacteria able to grow under aerobic conditions were somewhat higher in bloating than in the same animals treated with penicillin, but these bacteria are of relatively little importance because of the small numbers found. A comparison of the flora in the Ladino clover-fed animals with animals on alfalfa hay\* not producing bloat indicated a somewhat lower pH, a much higher total anaerobic count, a higher proportion of bacteria presumptively grouped as Lachnospira and Butyrivibrio and a somewhat lower proportion of cellulolytic bacteria in the Ladino clover-fed animals. Qualitatively, the flora was quite similar. The data indicate that the flora of the rumen of bloating and non-bloating cattle on Ladino clover is not grossly different.

\*or fresh alfalfa



Bacteriological studies on the flora of the rumen of two animals on a high concentrate-feedlot bloat ration indicate that the proportions of various groups of predominant bacteria, total anaerobic bacterial counts, numbers of protozoa, and pH of rumen contents can vary considerably and the animals will still bloat. Feeding of procaine penicillin caused the animals to go off feed and bloat was stopped. This correlated with drastic lowering in total anaerobic bacterial count and cellulolytic bacterial count and a drastic change in the proportions of groups of bacteria isolated. On subsequent penicillin feeding there was an adjustment in that the animals continued to bloat, did not go off feed, cellulolytic counts were raised and many groups of bacteria not found among the predominant bacteria when penicillin was first administered were among the predominant bacteria. One animal which had a somewhat abnormal rumen before penicillin treatment, e.g., low pH, very few protozoa and very high anaerobic bacteria count, had a more normal picture in these respects after continued penicillin treatment. The results of this limited study do not suggest any group of bacteria that might be concerned to a greater extent than others in feedlot bloat. The effect of penicillin on the rumen flora in feedlot bloat appears to be more drastic than in legume bloat.

Preliminary chemical assays indicated that the free-reducing, hydrolyzable sugars and starch content of Ladino white clover, alfalfa, red clover and other legumes did not appear correlated with the incidence of bloat of indexed steers. No large or consistent trends in the above sugars and starch contents were observed when legumes were sampled at four-hour intervals for a period of 24 hours. Limited weather data indicated that weather may have considerable influence on the bloating potentiality of legumes.

Plans: Work will continue on the various aspects of the problem and work on the part saliva may play. Further work is particularly needed on comparisons of bloat-susceptible cattle and non-bloat susceptible cattle, the microbiology and chemistry of rumen contents in animals fed and not fed penicillin, fats, etc. Further physiology and anatomy studies are needed. The metabolic characteristics of predominant strains of rumen bacteria should be thoroughly studied so that minor differences in activity of these strain may be detected. More complete weather records will be taken, especially aspects of solar radiation.

#### Publications

Studies on the Experimental Production and Prevention of Bloat in Cattle. I. Influence of Intrarumen Administration of Fresh Egg-white on Production of Bloat. J. M. Boda, B. S. Silver, H. W. Colvin, Jr., and H. H. Cole. J. Dairy Sci., Vol. 40, No. 7. July 1957.

Studies on the Experimental Production and Prevention of Bloat in Cattle. II. The Influence of Dehydration on the Bloat-producing Ability of Alfalfa. J. M. Boda. J. Dairy Sci., Vol. 41, No. 2. Feb. 1958.



Publications (continued)

Esophageal Innervation and the Eructation Reflex in Sheep. R. W. Dougherty, R. E. Habel, and H. E. Bond. Amer. J. Vet. Res. Vol. 19, No. 70. Jan. 1958.

Practical Measurement of the pH of Rumen Fluid. R. E. Nichols. J. AVMA, Vol. 131, No. 2. July 1957.

Rumen Study Techniques, Volatile Fatty Acid Production and Bloat. E. C. Leffel. Proc. Univ. Md. Nutrition Conf. for Feed Manufacturers. 1958.

12. Mucosal-Respiratory Disease Complex

ARS-ADP

Problem: To determine the causes and methods of treatment and prevention of mucosal disease, virus diarrhea, and the respiratory disease of cattle.

Program: A continuing basic and applied research program to determine the causes of several diseases included in this group and to develop methods of treatment, vaccination, and prevention carried on in cooperation with State agri. expt. stas. and veterinary colleges in California, Colorado, Indiana, and Iowa and involving approximately 8 professional Federal man-years annually.

Progress: Between August 1957 and July 1958, mucosal disease was diagnosed and reported in 37 States, virus diarrhea in 7 States, and infectious bovine rhinotracheitis in 19 States. Transmission trials and experimental production of mucosal disease are still very discouraging. Many efforts to reproduce a case in cattle with resulting symptoms and lesions similar to those seen in the field have met with failure. It was suggested that successful transmissions have been made but the experimentally produced disease resulted only in some temperature rise, leucopenia, and slight lesions in the mouth and the cattle quickly recover, indicating that a virus might be the cause. A virus was isolated from tissues of field cases which produced an ulcerative inflammation of the mouth for which the name "infectious bovine ulcerative stomatitis" was suggested.

Virus diarrhea studies in calves have been hampered by lack of known susceptible animals. The use of cortisone as a stressing agent has been helpful in establishing infection. The most usual form this disease has taken has been one in which the calves and young cattle show a febrile reaction, nasal discharge, moderate to severe diarrhea, erosions in the mouth, dehydration, variable lameness, and failure to make weight gains after apparent abatement of clinical signs. Diarrhea may persist in some animals for four to six weeks. There are no simple serological tests available for the detection of the viral diarrhea agent, or for the demonstration of immune bodies in the serum of recovered animals. In the laboratory, cross-protection



tests, using susceptible calves, have been utilized to establish evidence of infection in experimentally infected animals and in selected field cases. This procedure is time consuming and costly. The virus causing virus diarrhea, Indiana strain, was established in swine. Propagation in continuous cell culture was unsuccessful.

The upper respiratory disease studies have shown vaccinated animals were immune to challenge with nasal installations of the virus for at least one year, but intratracheal installations of the virus produced disease in vaccinated cattle a few weeks after vaccination. The virus is being grown in a wide range of cell types in tissue culture and the cytopathogenic effects have been determined.

Plans: Continue efforts to transmit these diseases and recover and identify the specific agents. Efforts to develop seriological tests and effective vaccines will be continued. Accuracy of differential diagnosis of these diseases will be enhanced by these studies.

#### Publications

Infectious Bovine Ulcerative Stomatitis. W. R. Pritchard, R. M. Claflin, D. P. Gustafson, and M. Ristic. 61st Ann. Proc. U. S. Livestock Sanitary Assoc. Nov. 1957.

An Infectious Ulcerative Stomatitis of Cattle. W. R. Pritchard, R. M. Claflin, D. P. Gustafson, and M. Ristic. J. AVMA, Vol. 132, No. 7. April 1958.

Incidence and Mortality of Mucosal Disease in Iowa. F. K. Ramsey, W. H. Chivers, A. L. Trapp, and C. E. Whiteman. Iowa State College Vet., Vol. 20, No. 2. 1958.

### 13. Poisonous Plants

ARS-ADP

Problem: Determine the effects of plants known or suspected as being poisonous or suspected as causing or contributing to sickness, abortion and death of cattle; and learn the toxic constituents of such plants as well as the symptoms, lesions, and pathology they produce in cattle to obtain information needed for the diagnosis and treatment of poisoning and sickness from plants in pastures and hay and the prevention of losses therefrom.

Program: A continuing long-term program involving applied and basic research and application of newly developed pharmacological, physiological, geological, chemical, and diagnostic methods and procedures carried out at the Animal Disease Lab. at Logan, Utah, in cooperation with the Utah Agri. Expt. Sta. and the U. S. Soil, Plant, and Nutrition Lab. at Ithaca, N. Y., and by surveys in cooperation with other State agri. expt. stas., and involving 2 professional Federal man-years annually.



Progress: Losses from plant poisoning are being reduced somewhat in some areas. Studies have continued on feeding tests on suspected plants. Chemical analyses on the blood and tissues of these animals and of the plants and the soil where they grow are being made. A plant not before known or reported toxic which produces marked redness and irritation of the udder, muzzle, vulva, and anus when fed has been found.

Plans: Work will continue and information will be developed by basic and applied research and surveys so as to prepare information on additional poisonous plants.

#### Publications

Sixteen Plants Poisonous to Livestock. Farmers' Bull. No. 2106, April 1958. (Each plant was also published as a separate leaflet.)

#### 14. Tumors in Cattle

ARS-ADP

Problem: Develop new information on the kinds of tumors, their location, frequency and importance; to improve present methods of identification; and to make tissue culture studies on their cells to establish the site of origin and relationship between various cancers and other tumors which are of economic importance in food-producing animals.

Program: A continuing long-term program involving basic research on the histopathology and cytology of various tumors of the bovine carried on at the Denver An. Dis. Lab., and involving approximately 1.5 professional Federal man-years annually.

Progress: A study was made of 18 primary epithelial tumors of the bovine gall bladder in which all were described and classified. Evidence suggests that papillary cystadenoma of the bovine gall bladder occurs with more frequency than has been thought. Some work has also been done on tumors of the acoustic nerve and on embryonal nephromas. The study was continued on tumors of the bovine reproductive organs in which a varied number of kinds of tumors were found. About one-fourth of the tumors in cattle are found in the reproductive organs.

Plans: Work on tumors of the bovine acoustic nerve and on embryonal nephromas will be finished in this fiscal year. Research on tumors and the application of tissue culture methods to the cytological studies of them are now contemplated through fiscal year 1960.

#### Publications

Neoplasms of the Genitalia of the Bovine. W. A. Anderson and C. L. Davis. Third Symposium on Reproduction and Infertility. Colo. State Univ., July 1957.

Epithelial Tumors of the Bovine Gall Bladder. W. A. Anderson, A. W. Monlux, and C. L. Davis. Am. Jour. Vet. Res. Vol. 19, No. 70. Jan. 1958.



15. Pathology and Identification of Diseased Tissues

ARS-ADP

Problem: Develop new and improved methods to increase the accuracy and speed in ascertaining the identity of pathological processes in food producing animals; and determine the causes and ways for the prevention of these lesions.

Program: A continuing long-term program involving basic histopathology and cytology studies as well as application of known principles and applied gross pathology, carried on at the Denver An. Dis. Lab. and involving approximately 1.5 professional Federal man-years annually.

Progress: The laboratory findings in 418 bovine granulomas from non-tested cattle submitted with a suspected diagnosis of tuberculosis were studied. The post-mortem diagnosis of tuberculosis was confirmed in 55% whereas 45% were found to be other conditions. The diseases most commonly confused with tuberculosis were actinobacillosis, coccidioidomycosis, mucormycosis, and Corynebacterium pyogenes infection. Neoplasms, particularly carcinomas, and lesions produced by migrating Pentastoma larvae in lymphatic glands were also mistaken for tuberculosis.

The gross and microscopic characteristics of 72 cases of chronic focal myositis in the bovine were determined for purpose of description, and to attempt to ascertain its possible relationship to the microscopic parasite of the genus Sarcocystis. The gross appearance of chronic focal myositis found was that of discreet foci scattered commoly through the muscles. The foci were about the size of a pin-head but some were one-fifth of an inch in diameter. They had a grey, yellow, greenish, or red color. It is believed that the cause of chronic focal myositis has not yet been conclusively demonstrated and that its importance justifies further research.

Plans: Some phases such as comparison of efficiency of histological sections of mesenteric lymph nodes and ileocecal valves with the stained smear technique in the demonstration of infection with paratuberculosis will be concluded during the coming year. A veterinary pathology atlas in color with gross and microscopic pictures of diseased tissues for use of meat inspectors and other veterinarians, and for training new meat inspectors and veterinary students in the recognition of diseases and diseased organs is planned.

16. Milk and Meat Studies Following Feedings of Radioactive Materials to Dairy Cows and Goats

ARS-ADP

Problem: The effects of fallout from hydrogen and atomic explosions in the defense program have created the problem of determining the amount of strontium 90 and calcium 45 that has to be ingested in contaminated forage to produce these radioactive substances as secretions in milk.



Program: This is a  $4\frac{1}{2}$  year contract involving basic research in the field of nuclear physics, chemistry, and biology being conducted through contract with the Lab. of Radiation Biology, Dept. of Veterinary Physiology, New York State Veterinary College, Ithaca, N. Y., involving approximately 3 professional Federal man-years annually.

Progress: Studies on calcium and strontium in lactating and nonlactating cattle and goats by double tracer methods showed calcium was preferentially secreted into milk by a factor of 11 over strontium in its passage from diet into milk. With corollary data from nonlactating animals, it was found that the largest amount of discrimination took place in the gastrointestinal absorption of these alkaline earths, calcium being from three to four times that of strontium. There appears to be differential movement of calcium and strontium between blood and bone and strontium is preferentially excreted in the urinary process.

About 1,000 references from the literature have been collected and abstracted, and will be published as an annotated bibliography. Six cows and two goats have been given radio-strontium (strontium 89) and radio-calcium (calcium 45), milk and blood samples have been taken, the animals have been killed and tissues collected from them. Radioassay analyses and chemical analyses are in progress.

Plans: This basic research will continue for the term of the contract. Work had been under way one year.

#### Publications

Comparative Metabolism of Calcium and Strontium in Lactation. R. H. Wasserman, F. W. Lengemann, and C. L. Comar. J. Dairy Sci., Vol. 41, No. 6. June 1958.

#### 17. Insecticide Residues in Animals, Feed, and Forage

ARS-ENT  
& ADP

Problem: Determine magnitude of insecticide residues in meat, milk, and forage occurring as a result of application of such materials for insect control.

Program: A continuing long-range program involving applied and basic research to develop chemical, bioassay and other techniques to identify and measure insecticide residues in meat, milk, and forage with a view to developing safe and nonresidue forming materials at Kerrville, Tex., and Corvallis, Ore., involving about 4 professional Federal man-years annually.

Progress: Good progress has been made in determining the magnitude of insecticide residues in meat, milk, and forage. Excellent progress has been made in developing new chemical and other techniques in measuring residues. Ultraviolet spectrophotometric and paper chromatographic methods have been developed to show the presence of rotenoids in milk or butter samples; the limits of sensitivity of these methods are 0.04 and 0.006 p.p.m. rotenone or dehydrorotenone. Milk from cows sprayed with five times the normal dosage of cube for cattle grub control contained no rotenoids within these limits of sensitivity.



Sevin, a carbamate compound for use in control of certain species of insects on forage, was found not to secrete in milk when cows were fed contaminated feed at rates of 2.5 p.p.m. to 50 p.p.m. on a weekly basis. This finding is encouraging. Another material, Dicapthon, an organic phosphorus material which has some promise for insect control, was fed to dairy animals at rates of 2.5 to 50 p.p.m. for one week. No detectable amounts of residues were found in the milk at any level of feeding.

Residues persisted in range cattle for 6 to 8 weeks after dipping and spraying with a lindane emulsion and a wettable powder at 0.075%. A somewhat higher percentage of lindane was found in the dipped animals the first week after treatment. Residues from the emulsion spray persisted longer than from the wettable powder spray.

A major finding has been that heptachlor transforms to heptachlor epoxide quickly when applied either to plants or fed to animals. Heptachlor epoxide persists for much longer periods in plants and animal tissues than does heptachlor.

The employment of radioactive insecticides has expedited research on several compounds. For example, American Cyanamid 12880 (dimethoate) labeled with  $P^{32}$  was found to be eliminated rather quickly by the animal when given orally or applied as a dermal spray.

Twenty-four compounds showing insecticidal effectiveness as sprays were evaluated for their poisonous properties when so applied. Three of this group were shown to be safe under the recommended conditions of use: Bayer 21/199 (also known as Co-Ral), Korlan grade of Dow ET-57, and Hercules AC 528 (Delnav). The remaining 21 will be evaluated further. Thirteen new insecticidal compounds of merit were studied to determine their potential as poisons when swallowed. Only one of these compounds, Bayer 21/199, was advanced to the status of a recommended insecticide. The other 12 will be evaluated further. Two compounds, Bayer 113/59 and Bayer 25,198, were evaluated for toxicity as injectible insecticides. Neither has reached the state of recommendation. New understanding of the effect of formulation in such applications was obtained and will be used in further studies. Extensive toxicology studies were run on Co-Ral (Bayer 21/199), the highly effective treatment against cattle grubs before they appear in the back and against screwworms, using young dairy calves; thin, fat, emaciated, and pregnant adult cattle; numerous repeated sprayings under pressure, and by feedings or oral administration. It was found to be toxic to young dairy calves at 0.5% as a single application, but adult cattle tolerated multiple treatments. When fed in the amount of 15 milligrams of Bayer 21/199 per kilogram of body weight, it did not produce poisoning in yearling cattle. Dairy cows were sprayed with 0.5% and 0.75% of this compound which had been labeled with radioactive Phosphorus<sup>32</sup>. It appeared in the milk five hours after treatment at 0.196-0.245 p.p.m. and at two weeks thereafter at 0.001-0.003 p.p.m. or one to three milligrams per 1,000 quarts of milk.



A variety of laboratory procedures, including electrophoresis of proteins, total blood proteins, blood sugars, carbon dioxide combining power, and icterus index were explored for their usefulness in determining toxicological effects. A total of 7,109 bloods were assayed for cholinesterase activity.

A total of 397 omentectomies (surgical removal of a portion of the omentum or caul fat) were performed to obtain samples for chemical analysis for studies on insecticide residues in meat.

Plans: Residue studies are planned to determine if several new and promising insecticides store in meat and milk when applied directly to animals or to the feed they consume. Work will be intensified with the chrysanthemumic acid esters and other carbamates which show insecticidal effectiveness.

#### Publications

Treatment of Organic Phosphate Insecticide Poisoning with Atropine Sulfate and 2-PAM (2-pyridine aldoxime methiodide). G. T. Woodard. Vet. Med., Vol. 52, No. 12. Dec. 1957.

Pesticide Residues, Spectrophotofluorometry for Pesticide Determinations. I. Horstein. J. Agr. and Food Chem. 6(1).

Demeton Residues on Fruits, Vegetables, and Forage Crops. Lillian I. Butler and W. E. Westlake. J. Econ. Ent. 50(6).

#### 18. Helminthological Investigations

ARS-ADP

Problem: To increase and make available to the dairy and livestock industry knowledge of the helminth parasites of cattle and the diseases they cause, including their economic importance, occurrence, and distribution, and to develop practical methods for their control and prevention in order to minimize losses caused by them.

Program: A continuing long-term program involving basic physiological and ecological studies as well as applications of known principles in the control of helminthic infection, carried out at Beltsville, the Regional Animal Disease Lab., New Mexico, and in cooperation with the State Agri. Expt. Stas. of California, Georgia, Kentucky, and Mississippi, involving 11 Federal professional man-years annually.

Progress: Results of research to obtain a more accurate estimate of the losses caused by internal parasites in cattle in Georgia and neighboring States and the factors that lead to these losses substantiate that diseases due to infection with gastrointestinal roundworms is widespread in Georgia and Florida. The average loss was estimated to exceed \$2,500 on six farms in Georgia on which outbreaks occurred and were investigated. Of the cattle on pastures in which these outbreaks occurred, 9% died and a considerably higher percentage lost weight. The animals had been maintained on these pastures continuously



for several months at a stocking rate of about 1 head per acre. The outbreaks occurred in the fall and winter months. Beef livers having an estimated value in excess of \$140,000 were condemned during the year at 4 abattoirs in Georgia and 5 in Florida, because of liver fluke. A species of cattle roundworm not previously known to occur in the U. S. was discovered in some cattle examined. These findings show that internal helminthic parasitism diagnosis must be done by careful examination of the animals postmortem and of the parasites recovered from them.

An experiment carried out at the Regional Lab. at Auburn, Ala., showed that fall and winter temperatures permitted the development on pasture and the survival of the infective larvae of the medium and small stomach worms of cattle in considerable numbers. These temperatures largely prevented the development or survival of the infective larvae of some other common gastrointestinal roundworms of these animals. Low grade infections acquired by some calves that grazed the test pastures in winter were not detrimental, but those calves that became moderately infected suffered a marked reduction from the normal in weight gained.

An experiment was carried out to test the effect of intensity of grazing on the level of parasitic infection in calves in Georgia. Conditions of overgrazing, moderate grazing, and undergrazing of temporary winter pasture mostly seeded to oats were set up using yearling cattle. The animals from the overgrazed pasture harbored at autopsy nearly 10 times as many gastrointestinal roundworms as were recovered from the yearlings from the undergrazed pasture, and gained only about half as much as the last-named group. Forage on the overgrazed pasture was much more heavily contaminated with infective roundworm larvae than that on the undergrazed pasture, and the animals on the first-mentioned pasture evidently grazed over a larger area each day than those on the latter. Yearlings from the moderately grazed pasture yielded about 3 times as many worms as those from the undergrazed pasture. These results show that the intensity of grazing was correlated with the contamination of the pastures and the worm infections acquired by the cattle grazing them.

In an experiment at State College, Miss., the intensities of worm infections in 4 groups of cattle grazed on temporary pastures sown with different grasses or grains, and combinations of grasses were compared, to determine whether the parasitisms acquired by the cattle were related to the type of forage grazed. No significant differences in degree of gastrointestinal roundworm infection in the cattle on pastures sown to ryegrass, oats-ryegrass, rye-ryegrass, or wheat-ryegrass, were observed. There was very little difference between the forage on the three combination pastures or between these and the rye-grass pasture by the end of the grazing period because the ryegrass became the predominant forage on the combination pastures. Available data from similar tests at Raymond, Miss., seem to indicate that the degree of worm infection in the cattle was not markedly influenced by grazing on one as compared to another of these four types of pastures. Exposures to parasites in these studies apparently were relatively light and under the conditions of the experiments could not be well controlled.



It was found at Beltsville that a pasture heavily contaminated with eggs of common gastrointestinal roundworms in October became highly infectious during the following winter months. Fatal infections were acquired by calves that grazed on it during this period. It was still highly infectious in the spring. The infectiousness of pastures contaminated in the spring did not diminish as rapidly as that of pastures contaminated with eggs in the summer and that very few infective larvae developed on pastures contaminated with eggs in November. It appears that grazing by infected cattle early in the fall may lead to more dangerous and persistent contamination of pastures with infective larvae than grazing at any other time. A further implication is that during the fall a difference of one month in the time of contamination may mean the difference between dangerous and safe conditions for grazing the following spring.

An experiment using 4 pairs of yearling cattle was conducted in Georgia to ascertain whether the poor gains of yearlings on fescue pastures were due primarily to inferiority of this forage or to the fact that cattle on these pastures often harbored more gastrointestinal roundworms than comparable animals grazing on other forages. The results indicated that the presence of much heavier worm loads in the pair on grazing alone was responsible for their very poor gain. A second pair of heavily parasitized animals that were fed a grain supplement in addition to the pasture made the best rate of gain. Comparable lightly parasitized animals on the same kind of pasture gained slightly less than the last mentioned pair and at about the same rate as lightly infected animals that were given the grain supplement. These studies show that good nutrition may be instrumental in controlling the clinical effects of parasitism in the individual animals. Animals appearing to be in good physical condition could contribute substantially to the infestation of pastures that could become potentially dangerous to cattle on a limited ration, or on grazing alone.

In an experiment on the artificial production of resistance or immunity to infection with the cattle lungworm, the possible advantage of the use of small initial doses of infective larvae plus a moderate dose of immune serum, as compared to the use of small doses of larvae alone, is being tested. The object of use of the serum was to prevent or minimize any adverse effects of the immunizing infection and the dissemination of lungworm larvae on pastures during its course. Early indications are that these goals were not achieved; perhaps because of an incorrect relationship between number of larvae and amount of serum, or because of an unexplained deficiency in the potency of the immune sera used.

The nature of changes in the blood of parasitized calves was studied in Kentucky to more exactly define the physiological changes produced in animals by internal parasites. Infections with the stomach hairworm caused a decrease in the total amount and markedly upset the normal balance of the serum proteins of the blood. Albumin, an important protein component, decreased in amount. The Alpha-2 globulin increased or remained constant, whereas the other globulins decreased. In heavily infected animals that became acutely ill, the volume of circulating blood decreased and the number of red cells per unit volume increased,



but if the animal survived the acute attack, the concentration of red cells decreased to subnormal levels in later stages of the disease. Since these changes undoubtedly are correlated with different phases of the disease produced by the stomach hairworm, their relative significance must be evaluated before disease can be thoroughly understood and methods for combatting formulated.

In California, changes in the blood constituents, including serum proteins, were studied in cattle suffering severely from naturally acquired infections with a number of species of worm parasites. Where the large stomach worm was absent, anemia was only moderate in degree and did not develop until shortly before death occurred. The amount of protein in the blood serum of most animals was found to be below normal. The life span of the red blood cells also was below normal. Although there was no evidence of compensatory increase in the production of hemoglobin, the amounts of iron and copper in the plasma appeared to be adequate for the synthesis of hemoglobin. There were changes from the normal in the values for bicarbonated, chloride, potassium, and sodium ions in the serum. It is not yet known whether, aside from worm removal by drugs, means can be found for reversing these changes, thus protecting the animal against death.

Plans: Additional data will be obtained on the regional incidence of worm parasites and helminthic disease in cattle. This information together with that now available will be used to determine the direction that should be taken in future research on the ecological relationships between parasites and pastures and between nutritional deficiencies and clinical parasitism. The effect of season on the degree and longevity of parasitic infestations on pastures will be further tested. Biochemical and physiological studies of the alterations caused in the host by infection with species not yet tested will be undertaken. The relationship between immune serum, infective lungworm larvae, antibody titer, age of the animal and other factors in the production of immunity to cattle lungworms is to be further investigated.

Efforts are to be made to assess the relative importance of height of forage, length of the grazing period, season, forage intake, extent of larval contamination of forage, kind of forage, and various pasture rotation schemes, as determinants of the degree of helminthic parasitism acquired from pastures by cattle. The effect of different kinds of supplemental feeding of cattle on worm parasitism will be studied.

#### Publications

Cooperia mcmasteri and Cooperia surnabada in the United States. R. W. Allen and W. W. Becklund. J. Parasit. 44(5). 1958.

Bovine Oesophagostomiasis. W. W. Becklund. Vet. Med 53(103). 1958.

Spinose Ear Ticks, Otobius megnini, on cattle in Georgia. W. W. Becklund and F. E. Mitchell. Ga. Vet. 10(1). 1958.



Publications (continued)

Occurrence of the Nematodes Trichostrongylus longispicularis and Ostertagia lyrata in Cattle in Georgia, With Notes on Characteristics of the Specimens. W. W. Becklund. Proc. Helm. Soc. Wash. 25(1). 1958.

Studies on the Effect of X-rays on the Infective Stage of the Nematode, Trichostrongylus axei. H. Ciordia. Prog. and Abst. 32nd Ann. Meet. of Amer. Soc. Parasit. Jour. Parasit. 43(5, Sect. 2). 1957.

Relationship of Escherichia coli to the Development of the Preparasitic Stages of Various Cattle Nematodes. H. Ciordia and W. E. Bizzell. Prog. and Abstr. 33rd Ann. Meet. Amer. Soc. Parasito. Jour. Parasit. 44(4, Sect. 2). 1958.

Keys to the Identification and Differentiation of the Immature Parasitic Stages of Gastrointestinal Nematodes of Cattle. F. W. Douvres. Am. J. Vet. Res. 18(66). 1957.

The Morphogenesis of the Parasitic Stages of Trichostrongylus axei and Trichostrongylus colubriformis, Nematode Parasites of Cattle. F. W. Douvres. Proc. Helm. Soc. of Wash. 24(1). 1957.

The Morphogenesis of the Parasitic Stages of the Cattle Lungworm, Dictyocaulus viviparus, in Experimentally Infected Guinea Pigs. F. W. Douvres and J. T. Lucker. Prog. and Abstr. 33rd Ann. Meet. Amer. Soc. Parasit. J. Parasit. 44(4, Sec. 2). 1958.

Cross Transmission of Nematodes of Domestic Animals. II. Infection of a Calf with Hyostrongylus rubidus, the Red Stomach Worm of Swine. F. W. Douvres and F. G. Tromba. Proc. Helm. Soc. Wash. 25(1). 1958.

Blood and Plasma Volume, Total Serum Protein, and Electrophoretic Serum Fractionation of Calves Experimentally Infected with Trichostrongylus axei. S. E. Leland, J. H. Drudge, and Z. N. Wyant. Prog. and Abstr. 33rd Meet. Amer. Soc. Parasit. J. Parasit. 44(4, Sec. 2). 1958.

The Effect of Green Feed Upon the Development of Trichostrongylus axei in the Laboratory Rabbit. G. H. Rohrbacher, Jr. Prog. and Abst. 32nd Ann. Meet. Amer. Soc. Parasit. J. Parasit. 43(5, Sec. 2). 1957.

Livestock Parasites and Grass. B. Schwartz and H. H. Vegors. Sci. Monthly 84(5). 1957.

Resistance of Cattle to Infection with Cooperia punctata. T. B. Stewart. Proc. Helm. Soc. of Wash. 25(2). 1958.

Nodular Worm Disease, or Oesophagostomiasis. T. B. Stewart and W. W. Becklund. Ga. Vet. 9(1). 1957.

A Preliminary Study of Lateral Migration by Infective Larvae of Some Cattle Nematodes on Experimentally Contaminated Forage Plots. I. B. Tarshis. Proc. Helm. Soc. 25(2). 1958.

Publications (continued)

Observations on the Arrested Development of Cattle Nematodes. H. H. Vegors. Prog. and Abstr. 32nd Annual Meet., Amer. Soc. Parasit. J. Parasit. 43(5, Sec. 2). 1957.

Observations on Inhibited Development of Cattle Nematodes. H. H. Vegors. Proc. Helm. Soc. 25(2). 1958.

Freezing Procedures for Greater Flexibility in Application of the Digestive Method for Postmortem Recovery of Cattle Nematodes. H. H. Vegors and W. E. Bizzell. J. Parasitol. 43(5). 1957.

Observations on the Relation of Serum Protein Changes, Antibody Formation, and Eosinophilia in Cattle Infected with the Lungworm, Dictyocaulus viviparus. T. B. Weber. Prog. and Abstr. 32nd Ann. Meet. Soc. Parasitol. J. Parasitol. 43(5, Sec. 2). 1957.

Immunity in Cattle to the Lungworm, Dictyocaulus viviparus: A Test of the Persistence of Acquired Resistance. T. B. Weber. Jour. Parasitol. 44(2). 1958.

The Eosinophilic Response to Infection with the Cattle Lungworm, Dictyocaulus viviparus. T. B. Weber and R. Rubin. Jour. Inf. Dis. 102. 1958.

19. Antiparasitic Investigations

ARS-ADP

Problem: Develop new and improved measures for the treatment and chemical control of parasites and parasitic diseases.

Program: A long-term program of applied and basic research on chemotherapy and control of protozoan, helminthic, and arthropod parasitism involving development of useful antiparasitic agents; design of efficient methods of systematic, preventive medication; evaluation of agents and methods from all standpoints referable to safety, efficiency, and simplicity; and determination of the mechanisms of drug action carried on at Beltsville, Albuquerque, New Mex., Auburn, Ala., and at other locations in cooperation with State agri. expt. stas. and involving about 1.5 professional Federal man-years annually.

Progress: Bovine venereal trichomoniasis has been successfully treated by a refined technique and a new chemotherapeutic agent. A drug screening method, using artificially infected hamsters, has continued to prove useful in the search for a safe, efficient systemic drug. Present treatment requires difficult anesthesia, time-consuming topical application of cumbersome materials, and prolonged post-treatment observation. A tranquilizer, promazine hydrochloride, was discovered to work exceptionally well in lieu of anesthesia and caused full relaxation of the penile retractor muscles. Two infected bulls were cured by five daily douches of 1% Berenil solution, a procedure made possible with tranquilization. The drug is a comparatively new German product. Berenil failed when applied topically as a salve.



In anthelmintic trials, high efficiency against a wide range of gastrointestinal parasites was obtained with the organophosphate compound, 21/199, at oral dosages of 6 to 25 mg./kg. The material, applied as a spray, is a new "dermal systemic" against warbles. It is not yet recommended as an anthelmintic because of toxicity hazards, but was well tolerated in 9 trials with grade Jersey calves in which it exhibited a broader spectrum of action than phenothiazine. Comparatively small and apparently safe doses of this drug are effective against at least two economically important kinds of parasitic worms, *Cooperia* and *Strongyloides*, that are not removed by phenothiazine or any other known drug. This is the first substantial support to the hope that an antiparasitic chemical may one day be found.

Progress is being made in the evaluation of chemical measures against cattle grubs. Many antiparasitic agents proved ineffective, but systemic organophosphate compounds showed encouraging activity. None gave results that warrant a national program of eradication.

Further evaluations of compound 13/59, administered as a drench, were conducted with a total of 603 animals in Illinois. In preliminary trials, 6 treatments at biweekly intervals had proved 100% effective. In toxicity trials with compound 13/59, involving 126 animals, single oral doses of 1.5 to 3 gms. per cwt. produced mild to severe toxic reactions in 35 of 55 treated bovines; doses of 1 gram per cwt. caused no reactions in 61 animals tested. Field trials involving 40 principals and 106 controls were conducted on 12 farms; principals received one treatment each of <sup>one</sup> gram per cwt. as a drench in December. Evaluations were made by grub extractions in January, February, and March; the populations were mixed, about 60% *Hypoderma lineatum* and 40% *H. bovis*. A maximum efficiency of about 86% was obtained with 2 successive daily doses of 1.5 grams each in June, although 1 or 2 doses of 1 gram or less gave nearly as good results in most trials. The treatments reduced the incidence as well as intensity of infestation, although the chemical is competitively unacceptable on account of toxicity, low efficiency, and the apparent necessity of multiple treatments.

Comparative trials in Illinois with compound 21/199 (applied as a 0.5% wash, 2 liters per animal) and compound ET-57 (110 mgs./kg. per os per animal) showed no significant differences between these treatments. Both gave efficacies of about 92% and were well tolerated. Ten animals were treated with each chemical in August, and 10 in October; 39 were kept as controls. In comparable trials in New Mexico, with 55 animals treated with ET-57 between July and September, 54% developed grubs with an average of 1.8 grubs per infested animals as compared to 96% and 10 grubs, respectively, in 55 untreated controls. Of a total of 88 animals treated with 21/199 (0.75% spray, 2 quarts per animal), 67% developed grubs and the average per infested animal was 3.5 grubs; the controls showed 100% infestation and 14 grubs per head. Dimethoate, an organophosphate parasiticide, was tested in 34 cattle with an equal number of controls, but the results were less satisfactory than those with ET-57 and 21/199. Time of treatment during larval migration of the parasite seemed to have no influence on efficiency. These data represent the most thorough comparative trials so far



conducted with available systemics. Cooperative trials with ET-57 in Montana, involving 44 principals treated with 130 mgs./kg. and 88 untreated controls, showed more than 95% efficiency; there was no intoxication.

New data were obtained on cross-transmission, injuriousness, and reservoirs of scabies mites. An experimental bull died after 7 years' continuous infestation with psoroptic scabies, the infestation being regarded as a contributing cause of death. A few mites were put in one ear of a healthy rabbit and this animal died of generalized mange in about 3 months, after losing much weight. Attempts to transmit mites and mange from ruminants to horses were unsuccessful, but attempts will be continued. A mite was discovered on infected cattle which is predaceous and lives on other mites of the genus *Psoroptes*. Losses under Federal dipping with BHC at the Port of Entry at Nogales, Ariz., were ascribed to depleted fat reserves of the animals; the chemical is presumed to have a propensity for infiltration of nerve tissue unless adequately buffered by fat.

Many chemicals were tested for acaricidal action, using a specially designed technique that employs the foot scab mite, *Chorioptes bovis*; certain carbamates, as well as organophosphates, were highly effective. These trials not only have the potential of revealing new treatments but also throw light on mode of action of available ones.

Plans: Attention will be given to common psoroptic scabies and internal parasites, with emphasis on new knowledge and better measures of control. Researches will be continued to throw new light on feasible approaches to the cattle grub problem, and efforts will be made to develop antiparasitic knowledge by economical screening systems such as have already been successfully devised for scabies and trichomoniasis. Attention will be given to systemics against lungworms and safe, broad-spectrum chemicals against both internal and external parasites, as well as to the biology of parasitic diseases and the prospects of their biological or biotic control.

#### Publications

An Anthelmintic for Cattle and Sheep. Critical Tests of Efficacy of Bayer 21/199. H. Herlich and D. A. Porter. Vet. Med. 53(7). 1958

The Eosinophilic Response to Infection with the Cattle Lungworm, *Dictyocaulus viviparus*. T. B. Weber and R. Rubin. J. Infectious Dis. 102. 1958.

Control of Cattle Grubs by an Orally-Administered Organic Phosphorous Compound. W. C. Marquardt and D. H. Fritts. J. Amer. Vet. Med. Assoc. 131(12). 1957.

Critical Tests on the Efficacy of Dow ET-57 as an Anthelmintic in Cattle. (Abstr.). H. Herlich and J. M. Johnson. J. Parasit. 43, Sect. 2(5). 1957.

Winter Survival of Some Cattle Parasites on a Kentucky Pasture with Observations on the Effects of Low-Level Phenothiazine Treatment. J. H. Drudge, et al. Jour. Parasit. 44. 1958.



## 20. Protozoological Investigations

ARS-ADP

Problem: To increase and make available to farmers knowledge of the protozoan parasites of dairy animals, and the disorders they cause, including economic importance, mode of spread, occurrence, distribution, diagnosis, and other facts, and to develop practical methods for control and prevention, in order to minimize or avoid losses.

Program: A continuing, long-term program of research involving basic and applied studies of the broad problem of protozoan parasitisms in relation to economical production of milk, dairy products, and dairy animals, including life histories, mode of transmission, dissemination, ecology and physiology, of the organisms, and the pathology, immunology and serology of infections, their prevalence and economic importance, and the development of practical measures and procedures for prevention and control to minimize or avoid losses, carried on at Beltsville, the Regional Animal Disease Lab., Auburn, Ala., and the field station at Logan, Utah, and involving approximately 3 professional Federal man-years annually.

Progress: A promising method of preserving by rapid freezing, genital trichomoniasis samples collected from cattle for later diagnosis was devised. One of the problems in correct diagnosis of genital trichomoniasis in cattle at a distance from a laboratory is how to prevent death of the parasites before the actual examinations are performed. The best of several methods tested involved inoculation of the samples into tubes containing a special solution, and sealing the tubes which were then frozen rapidly by means of dry ice in a portable ice chest. After transportation to the laboratory the tubes were thawed rapidly and the contents examined microscopically and by culture. In an entire series of samples collected under field conditions, and kept frozen for as long as 2 weeks, trichomoniasis was diagnosed correctly in all. In samples kept frozen for longer periods, the percentage of correct diagnoses decreased rapidly. This technique offers promise of a means of making accurate diagnoses of trichomoniasis in bovines at some distance from a laboratory, which heretofore has been attended with difficulties because of rapid death of trichomonads after removal from the genital tract.

The reproductive-tract trichomonad of cattle, Trichomonas foetus, was not found in the digestive tract of farm raised pigs in Utah. This study was undertaken because it has been found that trichomonads from the digestive tract of swine can infect the reproductive tract of cows and bulls, be transmitted by breeding, and cause reproductive disorders. It was found that under experimental conditions the genital trichomonad of cattle can live, for a time at least, in the digestive tract of the pig. It has become important to know if the cattle trichomonad occurs naturally in the intestine of pigs. Large numbers of trichomonads from the intestines of 396 pigs raised on farms in Utah were studied by means of phase contrast and regular microscope. Structurally, all these trichomonads were found to be different from the cattle trichomonad.



It was concluded that the genital trichomonad of cattle may not be of common occurrence in swine in Utah. Because these parasites of swine can cause reproductive disorders in cattle, it is concluded that the reproductive tract of cattle may be susceptible to the action of trichomonads of whatever origin. Because of this possibility, complete control of genital trichomoniasis of cattle should involve control of the trichomonad parasites of any animals that may be associated with cattle on farms or elsewhere.

Studies of trichomonads from the reproductive tract of cattle and similar parasites from the nasal cavity of swine showed that the two forms, in addition to being almost identical, structurally, have almost identical physiologic requirements. This indicates that the trichomonad associated with atrophic rhinitis of swine may have originated from the reproductive tract of cattle and become adapted to life in the nasal tract of pigs. This finding points to the necessity of raising cattle separately from swine if dangers of interchange or trichomonad parasites between the two classes of animals, and concomitant ill effects are to be avoided.

That coccidiosis in dairy cattle can cause losses by reducing milk production, was discovered in Utah for the first time anywhere. This discovery arose from an investigation of possible causes of reduced milk production and sickness in a dairy herd last fall; the primary cause was determined to be winter coccidiosis. About one-fifth of the herd was severely affected with bloody scours, and other conditions typical of this disorder. The remainder were affected less severely. During the attack, which lasted about 2 months, the total amount of milk produced by the herd was about 25% less than normal. According to the owner, similar conditions have been encountered in previous years, usually during the time beet tops were being fed. The source of infection was not located, as infective stages of coccidia were not found in bedding or in soil of the lots occupied by the herd. Failure to discover these infective stages on premises occupied by the affected cows suggests the existence of a source of infection other than the ones now known.

Winter coccidiosis was the cause of sickness and death that occurred in two herds of young calves following the onset of cold weather last Fall. In one herd of 13 animals, 11 were so severely affected that weight was lost, 3 of these animals dying from the effect of prolonged bloody scouring. In the other herd, comprising 130 animals, 25 lost weight with 5 deaths. Treatment with Teniatol, a commercial preparation of diphenothone, appeared to be of benefit as the animals improved following treatment.

Treatment of calves with either sulfamethazine or sulfabromomethazine during an initial attack of coccidiosis may not interfere materially with development of immunity against this disease by animals so treated. This study which is a part of trials to develop methods of immunizing calves against coccidiosis confirms previous results. Calves that survived an immunizing infection administered one month previously, and,



at the same time, had been treated with the drugs named, were given challenge infections severe enough to kill control calves that had not been immunized. None of the immunized calves developed more than a mild form of coccidiosis and none shed more than a few oocysts in the droppings. This finding constitutes a forward step in investigations to devise means of protecting young calves against severe coccidiosis by immunization of the young animals before they are turned out on range or pasture. The reduced oocyst production by immunized calves may provide a means of reducing contamination of pastures and feed lots with the transmitting stages of coccidiosis, and for developing effective control measures.

The beneficial effects of immunity against coccidiosis comes from destruction of the sexual (oocyst-producing) stages of these parasites in the intestine. Studies showed that whereas the development of asexual (pre-sexual) stages of coccidia in immunized calves may not be affected materially, a large proportion of the sexual stages is destroyed by the immunity. Death of the sexual stages inhibits the development of oocysts and reduces contamination of premises with oocysts, the stage responsible for infection. This finding substantiates the postulate that beneficial results may be derived from studies to develop methods of immunizing calves against coccidiosis.

That freezing temperatures can inhibit the development of, or even destroy the vast majority of oocysts of one of the pathogenic species of coccidia that affect calves, was determined by laboratory tests this year. This study was undertaken because winter coccidiosis, a serious problem in the West, generally makes its appearance several weeks after the onset of freezing weather, under which conditions oocysts frozen in soil or in manure probably are not readily available to animals. Although freezing is known to be detrimental to coccidial oocysts of poultry and swine, it was thought that those responsible for winter coccidiosis of cattle may be resistant. Tests under laboratory conditions indicate that these oocysts may be adversely affected by freezing, even for a period of a few days, to the extent that they either become incapable of development or die. Glycerol, a compound known to enable other protozoan parasites and spermatozoa of cattle to resist freezing, failed to protect these oocysts against low temperatures. This finding throws doubt on the commonly accepted belief that oocysts of cattle coccidia are capable of developing during freezing weather in barnyards and on pasture and thus are a source of coccidiosis in animals frequenting these premises. It lends support to the growing idea that sources of infection of these parasites, other than soil, bedding and manure may exist in nature.

Basic studies of the interrelationships between coccidiosis and worm infections in calves showed that infections of the small intestinal hairworm may stimulate coexisting coccidial infections and enhance the damage done by the latter. Young dairy calves experimentally infected with large numbers of coccidia and small intestinal hairworms



were damaged so severely that they died. Other calves infected with the same number of coccidia alone, and others infected with the same number of hairworms, survived, although all became sick and growth was retarded. When small numbers of coccidia and hairworms were used the animals did not die but they were more severely affected and grew less than calves infected separately with twice as many of these parasites. The calves infected with small numbers of both parasites shed more oocysts in their droppings than did the ones infected with coccidia alone. This may indicate that calves harboring simultaneous infections of these two parasites may be more instrumental in seeding premises with the infective stages of coccidia, than those infected with coccidia alone. One of the ways to avoid severe coccidiosis is to minimize the seeding of pastures and other premises with oocysts. Since calves almost invariably acquire coccidiosis in mild form, and since hairworms, which are widespread, are more easily controlled than coccidia, control of the latter parasites may aid, to some extent, in the control of the coccidiosis.

Plans: Those phases of the investigations that concern the effect of coccidia and worm parasites on calves, studies of the occurrence of genital trichomoniasis on beef cattle on range and investigations of the physiology of trichomonad parasites of cattle are expected to be discontinued this year. Studies of physiology of trichomonads will be replaced by basic studies of blood-serum protein fluctuations in animals affected with coccidiosis and trichomoniasis to provide a better understanding of these diseases and of immunologic processes. The major position of this investigation may be completed by about 1960. Basic studies will be initiated to devise means of applying tissue culture techniques to the cultivation of parasite cells, as a means of investigating the broad problem of transmission of infectious disease by parasites and/or their cells and tissues. Studies of immunity as a control measure against coccidiosis are expected to be intensified.

#### Publications

The Endogenous Development of Eimeria zurnii a Pathogenic Coccidium of Cattle. L. R. Davis and G. W. Bowman. Amer. J. Vet. Res., Vol. 18(68). 1957.

The Endogenous Development of Eimeria alabamensis, Christensen, 1941, an Intranuclear Coccidium of Cattle. L. R. Davis, G. W. Bowman, and D. C. Boughton. J. of Protozoo. 4. 1957.

The Effect of the Immune Reaction in Calves on the Numbers of Schizonts of Eimeria bovis. D. M. Hammond, R. A. Heckmann, M. L. Miner, C. M. Senger, and P. R. Fitzgerald. J. of Protozoo. 5(3). (Supplement). 1958.

Studies on Trichomonads. I. The Metabolism of Trichomonas foetus and Trichomonads from the Nasal Cavity and Cecum of Swine. D. J. Doran. J. Protozoo. 4(3). 1957.



Publications (continued)

Studies on Trichomonads. II. The Metabolism of a Trichomonas batrachorum-type Flagellate from the Cecum of Swine. D. J. Doran. J. Protozoo. 5(1). 1958.

21. Control of Biting Flies

ARS-ENT

Problem: Develop more effective non-residue forming insecticides and other measures for control of horn flies, stable flies, horse flies, and mosquitoes affecting dairy cattle -- measures that will reduce losses from these pests and result in greater production of milk and higher income for growers.

Program: A continuing long-term program involving applied and basic research to develop insecticides and other control measures for safe use on animals or natural breeding places of insects, and development of formulations with minimum residue potential and long protection periods, at Kerrville, Tex.; Corvallis, Ore.; Stoneville, Miss.; and Lincoln, Neb., involving approximately 4 professional Federal man-years annually.

Progress: Horn flies - Control of biting flies on dairy cattle is difficult and research has been hampered because many insecticides secrete in the milk in small amounts. Although some promising materials are available for the control of horn flies on beef cattle these cannot be recommended for use on dairy cattle. We must rely on pyrethrum type sprays which do not appear in the milk, but they are expensive and not long-lasting. An advance has been made since methoxychlor dust was approved for use on dairy animals to control horn flies. One application will control these flies for about 3 weeks, but is ineffective against other biting flies and mosquitoes.

Stable flies - Progress on developing effective control measures against the stable fly, a widespread and vicious pest, has not been pronounced. Numerous compounds have been evaluated but they are little, if any, more effective than standard pyrethrum preparations. Studies in Nebraska show that residual sprays applied to known resting places of the stable fly provide some control, but it is not adequate. Research on flight range of the stable fly indicates it will migrate from farm to farm within a radius of about one mile. The principle breeding places on farms appear to be in damp hay stacked near barnyards and waste hay and grain feed under feed bunkers and bins.

Horse and deer flies - Numerous insecticides and combinations of them have been evaluated in Oregon, Texas, Mississippi, and Nebraska for control of horse flies and deer flies on cattle. None of the chemicals gave much protection against biting flies. The breeding places of these pests are usually widespread and it does not appear practical to apply insecticides to these areas to obtain control.



Mosquitoes - Some of the newer chrysanthemumic acid esters have promise as animal protectant sprays against mosquito attack and may be somewhat longer-lasting than pyrethrum preparations. In addition these compounds may not create residue hazards. In Oregon 154 compounds were evaluated on cattle but none of them provided more than a day or two protection. Control of mosquitoes in their natural breeding places can be obtained by the use of several compounds, including DDT, lindane, malathion, and parathion. Aerial application or distribution of insecticides from ground equipment is effective against larvae or adults, but usually requires coordinated action by groups of landowners, and in addition the costs are rather high.

Plans: Research will be continued to find and develop more effective, non-residue forming, and lower cost sprays to protect livestock from biting flies and mosquitoes. Emphasis will be given to obtain a better understanding of the fate of sprays on animal hair and skin with the hope that the residue hazard will be minimized and protection time lengthened.

#### Publications

Aerial Spray Tests with Malathion, Pyrethrins, and Allethrin Against Aedes taeniorhynchus in Florida. A. N. Davis, E. J. Beidler, and J. D. Ringdahl. Mosquito News 17(3).

Further Studies with Water-Soluble Insecticides for the Control of Mosquito Larvae in Irrigation Water. J. B. Gahan. Mosquito News 17(3).

The North American Subspecies of Culicoides variipennis. W. W. Wirth and R. H. Jones. USDA Tech. Bull. 1170.

Controlling Flies on Dairy Cattle and in Dairy Barns. E. F. Knipling and W. C. McDuffie. Bull. World Health Org. 16(4).

Insecticides You Can Use on Dairy Cows. A. W. Lindquist. The Progressive Farmer 73(4). (Part I).

Livestock Insects--A \$1/2 Billion Problem. A. W. Lindquist. The Progressive Farmer 73(5). (Part II).

#### 22. Control of Screw-Worms

ARS-ENT

Problem: Develop non-residue forming screw-worm smears and other treatments to protect dairy animals and extend the principle of the sterile male technique of screw-worm control in areas other than the Southeastern States.

Program: A continuing long-term program involving applied and basic research to develop insecticides and other control measures for use in protecting animals, and use of the sterile male technique at Kerrville, Tex.; Corvallis, Ore.; Stoneville, Miss.; and Orlando, Fla., involving approximately 2 professional Federal man-years annually.



Progress: Laboratory and field research over the past several years to develop the basic information needed in the use of the sterile male technique over large infested areas culminated in the massive screw-worm eradication effort now under way in the Southeast.

Florida and the U.S.D.A. joined in a program last year for the eradication of the screw-worm in the Southeast. A large field test was conducted in late 1957 to perfect the method of rearing, sterilizing, and releasing a maximum of about 50 million flies per week over peninsular Florida. Unusually cold weather in December suggested that the screw-worm might be pushed deep into Florida and that early releases of sterile flies might prevent the pest from a northward spread. Fly production was started early in January in the research pilot plant at Orlando, Fla., while the large fly factory at Sebring was under construction. The early winter releases worked satisfactorily and the screw-worm was contained in exceedingly low numbers in the lower half of Florida throughout the spring and summer. There is every reason to believe that the eradication program will be successful.

Progress has been made with new screw-worm smears and livestock sprays to protect dairy cattle against this pest for use in southwestern areas. Bayer 21/199 (Co-Ral) and Dow ET-57 (Korlan) will destroy screw-worms in infested wounds and prevent reinfestation for about 2 to 3 weeks, but they produce very small amounts of residues in the milk and cannot at this time be recommended for dairy cattle. It is hoped that research will develop materials that will not secrete in the milk.

Plans: Efforts will be continued to develop low cost and highly effective sprays to protect animals against screw-worm attack and extend the principle of the sterile male technique for possible use in other areas for control of this pest.

#### Publications

Bayer 21/199 as a Deterrent to Screw-Worm Attack in Sheep. H. M. Brundrett and O. H. Graham. J. Econ. Ent. 51(3).

### 23. Control of Lice and Ticks

ARS-ENT

Problem: Development of more effective non-residue forming insecticides and other measures for the control of lice and ticks affecting dairy cattle that will reduce losses to growers.

Program: A continuing long-term research program involving applied and basic research to develop insecticides and other control measures for safe use on cattle with a minimum residue potential and long-term protection periods, at Kerrville, Tex.; Corvallis, Ore.; Stoneville, Miss.; and Lincoln, Neb., involving approximately 1 professional Federal man-year annually.



Progress: Several of the organic phosphorus insecticides, including malathion, Dow ET-57 (Korlan), and Hercules AC-528 are promising substitutes for lindane, toxaphene, and DDT for the control of lice on cattle, but unfortunately small amounts secrete in milk. One compound, ENT-21557, a chrysanthemumic acid ester, appears to control lice effectively on cattle and may not produce residues in milk.

Several new compounds have been evaluated for ticks but none are acceptable for use on dairy cattle. Currently recommended pyrethrum and rotenone sprays can be used with fair success, but much better materials are urgently needed.

Work is under way (coop ADP) to determine the role that ticks play in the transmission of anaplasmosis. This research is needed in developing effective control of the disease through control of the ticks.

Plans: Research will be intensified to find and develop substitute non-residue forming insecticides for use against lice and ticks on dairy cattle. The studies will include laboratory screening and field trials with both conventional type sprays and systemic insecticides.

#### 24. Control of Cattle Grubs

ARS-ENT

Problem: Develop effective non-residue forming systemic and other insecticides for control of cattle grubs in dairy cattle that will reduce losses to growers.

Program: A continuing long-term program involving applied and basic research to develop systemic and conventional insecticides and other control measures for safe use on animals to control cattle grubs at Kerrville, Tex.; Corvallis, Ore.; Stoneville, Miss.; and Lincoln, Neb., involving approximately 3 professional Federal man-years annually.

Progress: Wide-scale tests in cooperation with several states showed that the systemic insecticides, Dow ET-57 and Bayer 21/199, were highly effective against both species of cattle grubs under a variety of conditions. These insecticides cannot be used on dairy cattle because slight amounts secrete in the milk so it is necessary in controlling cattle grubs in dairy cattle to use the currently recommended rotenone spray. The disadvantage of this treatment is that at least 2 or 3 sprays on the animal are required during the coldest part of the year. New safe cattle grub systemics are needed.

Plans: Research will be continued to find and develop systemic and conventional-type insecticides that will not create residue hazards for control of cattle grubs in dairy cattle.



Publications

Ranch Tests Against Cattle Grubs with the Systemic Insecticide Dow ET-57. R. H. Jones, H. M. Brundrett, and R. D. Radeleff. Agr. Chem. 12(7)

Systemic Insecticides for Control of Cattle Grubs and Other Livestock Insects. A. W. Lindquist. Sixty-first Ann. Proc. U. S. Livestock Sanit. Assoc.

Tests with Bayer 21/199 for the Control of Cattle Grubs. O. H. Graham. J. Econ. Ent. 51(3)

Laboratory Screening Tests of Animal Systemic Insecticides. R. O. Drummond. J. Econ. Ent. 51(4).

25. Control of House Flies

ARS-ENT

Problem: Develop effective insecticides and other measures for control of resistant house flies and other filth- and disease-carrying insects, such as cockroaches, in and around dairy barns and dairy processing establishments.

Program: A continuing long-range program involving applied and basic research to develop insecticides and other control measures for combating resistant house flies and cockroaches safely and economically at Orlando, Fla.; Corvallis, Ore.; Kerrville, Tex.; Stoneville, Miss.; and Lincoln, Neb.; involving approximately 3 professional Federal man-years annually.

Progress: Resistance to insecticides continues to be the most important problem involving research on the control of house flies and cockroaches. House fly resistance to malathion is becoming pronounced in Florida, Georgia, and other places in the South. This insecticide both as a residual spray on walls, and in baits is less effective than formerly; Diazinon and Dipterex in baits are still giving fairly good control, but it is doubtful that this will continue very long. Laboratory and field tests with pyrethrins and allethrin plus the synergist piperonyl butoxide at ratios of 1 to 10 incorporated in sugar baits were effective for control of organic phosphorus-resistant strains of house flies in Florida. These formulations are not as effective as the organic phosphorus materials were originally, but they seem to do a fairly good job in combating flies where other materials fail. The German cockroach is already resistant in most localities to chlordane and dieldrin, and shows signs of resistance to lindane and pyrethrins. Malathion and Diazinon are still effective.

Special tests show that the use of malathion and DDT, alternately, concurrently, or separately, did not prevent resistance from developing in house flies. Exposure of flies to a mixture of DDT plus malathion for 30 generations caused a resistance to develop which

amounted to about 75 times that of normal flies. When these two insecticides were used on flies in alternating generations the resistance developed to about 30 times that of normal flies. The expectation of combating resistance by combining or alternating use of unrelated insecticides is not promising.

Plans: Investigations will be continued to find substitute insecticides and efficient protectants to control house flies and cockroaches and initiate studies to obtain information on the biological and physiological nature of resistance, with the hope of developing satisfactory counter-measures to control these pests.

#### Publications

Organic Phosphorus Insecticides as Residual Sprays for the Control of House Flies. J. B. Gahan, H. G. Wilson, J. C. Keller, and C. N. Smith. J. Econ. Ent. 50(6).

Tests with Organophosphorus Compounds as House Fly Larvicides in Poultry Houses. H. G. Wilson and G. C. LaBrecque. Fla. Entomologist 41(1).

The House Fly--How to Control It. USDA Leaflet No. 390

### F. HOUSING AND EQUIPMENT

#### 1. Effects of Environment on Dairy Cattle

ARS-AE  
& AH

Problem: To determine the effect of temperature and related factors on the growth, health, production and feed consumption of dairy cattle, and to obtain data for design of buildings to economically provide desired environmental conditions.

Program: The basic phases of this program are carried on in the 12-cow controlled-environment laboratory at Columbia, Mo., in cooperation with the Missouri Agr. Expt. Sta. and involves approximately 1.5 professional Federal man-years annually. The applied phase is carried on in cooperation with the Georgia Coastal Plain Agr. Expt. Sta. and involves 1 plus professional Federal man-years annually.

Progress: Studies of the growth rates of dairy calves in Missouri have been continued. These studies involved observations of Holstein, Jersey, and Brown Swiss calves from one month to 12 months of age, housed at 50° and 80° F. Average weight gains per day from 1 month to 12 months of age were for Holsteins 2.0 and 1.8, for Jerseys 1.3 and 1.2, and for Brown Swiss 1.9 and 1.9 lbs. at 50° and 80° F., respectively.

At the completion of these tests the calves were subjected to various temperatures ranging from 30° to 95° F. to determine if they had to any extent become acclimatized. No evidence of acclimatization could be detected. Calves grown in the 50° chamber stood high temperatures as readily as the calves grown in the 80° chamber.



Rectal temperature measurements indicated that an 80° air temperature was at the threshold of temperature stress as rectal temperatures were about 0.7° F. higher at 80° than at 50° among the Holsteins, 0.5° higher at 80° among the Jerseys, but the same among Brown Swiss calves at both air temperatures.

The ability of the calves to vaporize water from their skin and respiratory tract was found to be a possible index of their heat tolerance. The ratio of a breed's vaporization rate at 80° F. to its vaporization rate at 50° correlated very well with its relative heat tolerance. The breed with the highest ratio showed the greatest apparent heat tolerance.

Quantitative estimates of heat and moisture loads needed for design of dairy calf stable ventilation or air conditioning systems were obtained. Heat production from the calf stable (including heat from fermentation of manure and bedding) increased rapidly until the calves were 12 weeks of age, when the production was 6500 Btu per 1000 lbs. body weight, or about twice the rate per 1000 lbs. of mature animals. At one year of age the heat production in proportion to weight was about the same as for mature cows. Heat production rates in the 50° and 80° F. environments were approximately the same throughout the tests. Stable moisture dissipation rates were nearly twice as great at 80° as they were at 50° accounting for between 34 and 39% of the total heat at 50° and between 61 and 66% at 80°.

A study was begun on the use of field shades to increase summer milk production at Tifton, Ga. The cows were fed hay and silage in dry lots since it was not practicable to measure feed consumption of cows on pasture. The data are being prepared for analysis. Preliminary review indicates greater consumption of hay, more economical use of feed, and increased milk yield due to use of shades.

Plans: The laboratory studies in cooperation with the Missouri Agr. Expt. Sta. will test the effects upon lactating Holstein cows of high, medium and low levels of relative humidity in combination with moderate and high temperatures. Both engineering and physiological data will be obtained.

The studies of field shades in Georgia will be continued using improved techniques. More complete data on physiological reactions will be obtained.

#### Publications

Influence of Humidity and Wind on Heat Loads Within Dairy Barns.  
H. J. Thompson. Mo. Res. Bul. 618, Jan. 1957.

A Ten-Year Summary of Psychroenergetic Laboratory Research. R. G. Yeck and R. E. Steward. ASAE Ann. Meet., Santa Barbara, Calif., June 1958.



Ventilating Dairy Cattle Shelters. R. G. Yeck. Air Conditioning, Heat and Ventilating. Sept. 1958.

Predicting Heat Tolerance from Calf Vaporization Rates. R. G. Yeck and H. H. Kibler. Amer. Soc. An. Prod. Nov. 1957

Effects of Constant Environmental Temperatures of 50° F and 80° F on the Growth Responses of Brahman, Santa Gertrudis, and Shorthorn Calves. A. G. Ragsdale, Chu Shan Cheng and H. D. Johnson. Mo. Res. Bul. 642. Oct. 1957.

Energy Metabolism and Cardiorespiratory Activities in Shorthorn, Santa Gertrudis, and Brahman Heifers During Growth at 50 and 80° F Temperatures. H. H. Kibler. Mo. Res. Bul. 643. Oct. 1957.

Comparison of the Effects of Environmental Temperatures on Rabbits and Cattle. Part 1 - Influence of Constant Environmental Temperatures (50° and 80° F) on the Growth Responses and Physiological Reactions of Rabbits and Cattle. H. D. Johnson, A. C. Ragsdale and Chu Shan Cheng. Mo. Res. Bul. 646. Nov. 1957.

## 2. Labor Saving Studies

ARS-AE  
& FE

Problem: Determine inefficiencies in design and layout of dairy farmstead buildings and facilities that contribute to excess or waste in production labor; and develop designs and layouts that will permit the efficient use of labor and labor-saving equipment as a means of contributing to lowering of production costs.

Program: A program of engineering analysis of farmstead layout, building arrangement, and management methods, combined with labor time and travel studies on typical dairy farms, in cooperation with the California, Maryland, and Minnesota Agr. Expt. Stas., from which principles can be developed for application to the remodeling and improvement of existing facilities or construction of new facilities to provide for greater labor efficiency, involving about 3.5 professional Federal man-years annually.

Progress: In California, the studies were largely a continuation of work on layouts of corrals and milking rooms for large herds and methods of getting the cows into milking rooms, but with the addition of making comparisons between the rather common rectangular lots, or corrals, opening into a lane and the "pie-" or "wheel-" shaped pen layout for large dairies. The travel requirements for moving large herds of cows twice daily between the milking area and the feeding and housing areas becomes an important problem as the size of the operation increases. Tentative findings are: (a) Pie-shape corrals have the advantage of significantly shorter distances from lots to milking barn than do rectangular corrals; (b) Use of an ordinary elevated stall milking barn causes complications in moving large numbers of cows from and to the corrals, particularly if only a few stalls are used. Ways to relieve this difficulty are being studied; and (c) Improvements in gate



opening and closing mechanisms and controls, perhaps more remote controls, are needed. The same is true for feeding, water distribution and flushing equipment.

In Maryland, a study was begun on the time and labor requirements for caring for dairy animals. Approximately 200 farms were screened to select 20 representative of the area and having an interest in improvement, but with different sized herds, different building arrangements, different equipment and management methods. Physical measurements, management procedures and other information was recorded and time and travel studies made on milking operations. The study is still in an early stage, but the following significant observations are apparent: (a) Obsolete and unnecessarily restrictive requirements in milk codes relative to building and equipment features impose excessive and often unnecessary work loads on the operators; (b) Farmers are constructing dairy buildings without the benefit of adequate guidance on the labor requirements that will be involved in their use and are investing good money in poor facilities from the standpoint of labor-efficient feeding, milking, removing manure and otherwise caring for the animals. Planning guidance materials for use by Extension workers and farmers appear to be needed; and (c) There is a strong trend to adhere to tradition in buildings, rather than to adopt modern improvements. Farmers did not realize the inefficiencies of their layouts until pointed out by our engineer.

In Minnesota, a similar study was begun, using 20 dairy farms representative of the area. Partial analysis of early data indicates: (a) Milking time shows the largest differences between operators--due both to variations in worker efficiency and industry as well as variations in time requirements due to different housing and milking arrangements are not evident; (b) Travel distances per milking varied from 36 to 72 steps per cow for the 7 one-operator dairies analyzed. These figures are influenced by the type of milking machine, volume of milk produced, size of barn and whether or not a pipe line is used. (c) Feeding and bedding operations have generally not been as well organized as milking, and successive observations on any one farm would show considerable variation. Variations between farms are almost unlimited. Design of existing buildings is frequently inefficient for handling hay and bedding. Personal feelings of the operator are a major influence in these operations; and (d) There is a general need for improvement in building design, layout and equipment to reduce labor requirements. Such improvements might be expected to cut as much as 10-20% of the labor requirements from present-day good standard practices. Reductions on farms now handicapped by poor arrangements could considerably greater.

A preliminary study of the labor requirements of the new herringbone type milking parlor was made in 11 parlors in Iowa, Wisconsin and Illinois. Analysis of data has not been completed but the following observations appear pertinent: (a) An average workman should be able to do a good job of milking on two rows of 4 or 5 cows. Two rows of



6 cows requires above average skill, dexterity and industry for one operator, but provide "ample" time for a two-operator team and "leisure" time for a good team; (b) Milking rates observed varied from under 20 to over 60 cows per operator per hour; (c) In striving for speed of milking there is opportunity for an operator to slight individual attention to cows and cleanliness during the milking operation; (d) Concentrate feeder mechanisms in the parlors generally gave trouble, causing an operator to leave the milking pit to make adjustments during the milking operation; (e) Some cows are reluctant to enter the parlor, causing an operator to leave the milking pit to bring them in; (f) The arrangement appears to permit faster milking with a greater degree of operator comfort in a more compact structure.

Plans: As data from analysis of the study of existing dairies become available, it is planned to devise improvements in the layouts so as to make more efficient use of available labor resources. Improvements would be discussed with owners, and studies made on those farmsteads where the improvements are carried out, thereby obtaining data on their effectiveness. It is planned to develop methods and materials in co-operation with FES for explaining and demonstrating to farmers the importance of farmstead layout and building design in reducing the labor required in performing dairy chores and for showing how existing layouts can be improved.

### 3. Forage Harvesting and Storage Research

ARS-AE, AH,  
SWC & FE

Problem: Develop and evaluate new designs for silage storages and improved methods of harvesting, storing and feeding silage that will preserve the maximum nutritive value from all types of forage with a minimum cost of investment, time and labor.

Program: A long-term project concerned with the engineering, cropping and nutritional phases in economically harvesting, preserving and handling all types of forage crops as silage, including basic studies of the bacteriological and chemical aspects, carried on at Beltsville, Piedmont Soil Conservation Sta., Watkinsville, Ga., and the Georgia Agr. Expt. Sta., Athens, Ga., and requiring about 6 professional Federal man-years annually.

Progress: For a third season, study has been underway on comparing the feed-producing capacity of the direct-cut and indirect or wilting methods of harvesting grass silage. The criterion adopted for measurement of effectiveness was the amount of dry matter harvested per hour of chopper operation, although it is recognized that both crop yield (dry matter per acre) and crop moisture content will affect the harvesting rate. Studies on orchard grass and alfalfa again show that the wilting method of harvesting grass silage produces more dry matter per hour of harvester operation than the direct-cut method. The differential between methods increases inversely with crop yields, making windrow equipment even more advantageous for second- and third-cutting



operations, due to the fact that windrows may be combined to utilize the full capacity of the chopper. The wilting method also effects a rate in acres per hour almost twice that of the direct-cut method. Although the labor requirements for windrow pickup operations are somewhat higher than for direct-cut, the higher harvesting rates tend to compensate for this. These labor requirements may be reduced considerably through use of a combination tractor-mounted mower and rake or self-propelled windrower.

Results of storage studies show that the kind of crop, its moisture content and stage of maturity, and the amount of compaction all affect the magnitude of horizontal and vertical wall loads. Maximum horizontal pressures in 8 ft. deep horizontal silos varied from 120 lb. to 180 lb. and averaged 140 lb. per sq. ft., while maximum vertical loads varied from 60 lb. to 110 lb. and averaged 76 lb. per sq. ft. Higher densities of silage are associated with greater horizontal and less vertical pressures.

Plastic covers weighted with sawdust reduced total dry matter losses in bunker silos to about 15% in high moisture silage as compared to 21% in a tower silo filled at the same time with the same material. This difference was due principally to seepage as shown by a third comparison of wilted silage in a tower silo where the loss was about 14%.

Experimental coatings on the walls of concrete silos are still giving from adequate to good protection after 3 and 5 years of service. Several show signs of mechanical damage and peeling which may lead to coating failure. Plastic base preparations appear to offer the best possibilities at this time.

Plans: Study effective methods of preserving the nutritive value of standing crops from the field to the animal. Specific attention will be given to evaluation of new types of harvesting equipment and methods, the preservation of forage through use of different techniques in filling, packing and covering, and the handling or self-feeding of silage.

#### Publications

Some Experiments in Preservation of High-Moisture Hay-Crop Silages. C.H. Gordon, H. M. Irvin, C. G. Melin, H. G. Wiseman, and J. R. McCalmont. J. Dairy Sci., Vol. XL, No. 7. July 1957.

Problems in Hay Storage, Drying and Handling. J. R. McCalmont. Ohio Section Meet. of ASAE, Columbus, Ohio. Nov. 1957.

The Nutrient Losses and Feeding Values of Wilted and Direct Cut Forages Stored in Bunker and Tower Silos. C. H. Gordon, C. G. Melin, W. C. Jacobson, H. G. Wiseman, E. A. Kane, J. C. Derbyshire, J. R. McCalmont, and D. T. Black. ARS 44-25, June 1958.



Publications (continued)

Harvesting, Storing and Preserving Grass Silage. J. R. McCalmont, D. T. Black, and A. T. Hendrix. North Atlantic Section Meet. of ASAE, Guelph, Canada, Aug. 1958.

A Comparison of Chopped and Unchopped Silage Stored in Bunker Silos. G. H. Gordon, H. M. Irvin, H. G. Wiseman, C. G. Melin, J. R. McCalmont and L. E. Campbell. ARS 52-19.

Microbiology and Chemistry of Grass Silage. C. W. Langston, H. Irvin, C. H. Gordon, Cecelia Bouma, H. G. Wiseman, C. G. Melin, L. A. Moore, and J. R. McCalmont. USDA Tech. Bul. No. 1187. Sept. 1958.

4. Engineering Research on Bulk Milk Cooling Equipment

ARS-AE

Problem: Develop methods and equipment to utilize heat extracted from milk during cooling to preheat water.

Program: A 3-year project involving heat-pump principle of transferring heat extracted from milk in a bulk tank to preheat water for washing utensils or heating milk room or milking parlor is carried on at Washington Agr. Expt. Sta. and with dairymen in that State, and involves 1 professional Federal man-year annually.

Progress: A method and equipment have been developed to utilize heat extracted from milk during the cooling process to preheat water for use in washing milk utensils. During the year an ice-bank type bulk milk cooler heat pump has been operated under essentially the same conditions as was a 400-gal. direct-expansion cooler. This consists of using a 42-gal. preheat tank, circulating pump to circulate the preheat water, a milking load of 100 gal. per milking, and a milking rate of 100 gal. in  $1\frac{1}{2}$  hrs.

Two condenser arrangements were used. The first used a small water coil which is a small water-cooled condenser in series with the conventional air-cooled condenser, a normal installation for warm climates. With this arrangement it was necessary to control the operation of the fan on the fan-cooled condenser in order to preheat the water to the required temperature. It was only practical to preheat the water to 100° F. With this type of operation it was found that from 1,200 to 1,500 kw.-hr. could be saved annually. This compares with the 3,500 to 4,000 kw.-hr. saved annually with the direct-expansion system. This is based on the hot water consumption of 50 gal. used per milking. The second arrangement of the condenser used was a straight water-cooled condenser in which the water is circulated by circulating pump through the condenser and around through the preheat tank. This type of operation affords savings of 3,000 kw.-hr. per year while preheating water from 60° to 110° F, again based on a water usage of 50 gal. per milking. The main difference in operation and equipment between the direct-expansion tank and the ice-bank tank with the water-cooled



condenser is, the direct-expansion tank has a 2-hp. compressor and the ice-bank type has a 1-hp. compressor. Thus, it takes nearly twice as long to preheat a given amount of water to a given temperature.

Plans: It is planned that one of these types of bulk milk cooler heat pumps can be installed in an actual farm dairy in the near future. To date work has been done in the laboratory.

#### Publications

A Bulk Milk Cooler Can Be Harnessed to Heat Water. M. C. Ahrens. Hoard's Dairyman, Vol. 103, No. 19. Oct. 1958.

#### 5. Electric Equipment for Dairy Production

ARS-AE  
& AH

Problem: To develop new and improved types of electrically controlled and operated equipment to reduce labor in dairy production operations and to integrate equipment and related activities into automatic systems.

Program: A continuing study of the development and application of electrical equipment for dairy farms, conducted in cooperation with the Washington and Minnesota Agr. Expt. Stas., at Beltsville, and with other Federal agencies, and involving approximately 4 professional Federal man-years annually.

Progress: At Beltsville the performance of milk-flow meters and methods was investigated. Tests of a commercially available flow-type meter indicated the errors of this meter slightly exceeded the permissible error established by A.D.S.A. Observations were conducted to determine source of errors in both weighing and flow rates, variation of rate of milk production from individual cows, time of milking and stripping as related to milk flow rates, and to provide specific performance characteristics required of continuous-flow milk meters used on the farm. The results indicate need for re-evaluation of milk-handling equipment and related management procedures.

In Washington, a study was initiated to develop electric-powered units for removing silage from horizontal-type silos. A pilot model machine has been constructed and its performance and adequacy of design will be tested in operation during the winter of 1958-59.

In Minnesota, the performance of silo unloaders and gutter cleaners was investigated through the cooperation of farmer-owners. Tests of continuous-chain, belt, and shuttle-stroke gutter cleaners showed relatively similar performance in terms of manure unloaded per kw.-hr. of energy and reasonable satisfaction with dependability. Records obtained on eight makes of silo unloaders showed a wide variation in delivery of silage per kw.-hr. of energy and numerous operational difficulties. Studies of recent models is in progress, but a need appears to exist for additional investigations of fundamental operating principles, particularly for unloading frozen silage.



Plans: Studies of silage-removal equipment will continue with emphasis on fundamental operating principles. Milk metering equipment from individual cows will continue to receive attention. Emphasis will be given to equipment and management practices affecting milking time per cow and automatic feed-handling systems.

#### Publications

Preliminary Report on Tests of the Accuracy of Milk Scales. D. R. Mackay, J. G. Hartsock, and J. H. Book. J. Dairy Sci. Vol. 41, No. 2. Feb. 1958.

Report on a Milk-Flow Meter for Pipeline Systems. J. H. Book, D. R. Mackay, L. E. Campbell, and W. R. Harvey. ARS 44-20. June 1958.

Bibliography on Electric and Related Equipment for Livestock Production and Feeding. D. R. Mackay. ARS 42-22. Aug. 1958.

Gutter Cleaner and Silo Unloader Tests, A Progress Report. J. G. Hartsock and R. E. Larson. ARS 42-23. Minn. Agr. Expt. Sta. Misc. Jour. Series 980. Aug. 1958.

### G. ECONOMICS OF PRODUCTION

#### 1. Needed Farming Adjustments

ARS-FE

Problem: Increased efficiency and higher farm incomes frequently can be made through adjustments in the organization and operation of farms. But most of the income increasing adjustments also tend to increase production, and in a period of chronic surpluses, adjustments that are profitable for the individual farmer frequently run counter to the interests of the group. More information relating to costs and effects of alternative adjustments is needed to provide a better basis for managerial decisions by individual farmers and better guides for farm programs needed to cope with a major problem confronting American agriculture, that of agricultural surpluses.

Program: A series of studies dealing with profitable adjustments in farming is being carried on in cooperation with State agr. expt. stas. in representative farming areas. The study areas have been selected on the basis of their representativeness of broad areas and their adaptability to regional and national aggregation. The Department has been primarily concerned with adjustment opportunities available in broad areas and with the aggregate implications of adjustments that might be made on individual farms. In several dairy areas these analyses stress adjustments that typical dairy farmers can make to changing technology and to current and prospective market outlets, while in some of the non-dairy areas attention is given to the profitability of dairying as a supplemental dairy enterprise. This program involves about 4 professional Federal man-years annually.



Progress: Alternative farm plans have been worked out for typical 1-man and 2-man dairy farms in northeastern and north central Iowa to show optimum organization with present and projected price relationships and with usual and improved production practices. Reports covering this phase of the analysis are in the process of publication. In central Iowa model farm situations for various sized dairies were constructed. Costs of operation were calculated for different types of barn arrangements and other dairy investments. Preliminary results suggest that the "herringbone" milking parlor may not be well adapted to dairy farms in Iowa cash-grain areas. For a 2-man farm with about 50 cows the 6-stall milking parlor appears to be more economical.

Standard production requirements for various jobs and systems of dairy herd management have been computed for dairy farms in southeastern Minnesota as a preliminary phase of studying adjustment opportunities on such farms. Records of 90 dairy farms reveal considerable variation in labor used that apparently must be attributed to individual differences in the speed of the worker. For a 15-cow herd, 23.7 man-hours are needed weekly in summer and 35.2 man-hours weekly in winter. For a 20-cow herd, 27.9 man-hours are needed weekly in summer and 41.6 man-hours weekly in winter. Well over half the time is needed for milking. Installation of a milking parlor saves time. The best opportunities for reducing the total labor required in winter appear to be with such labor-saving devices as silo unloaders, gutter cleaners, and storage of baled hay near the feeding racks. A report on this phase of the study is being published.

An analysis of adjustments on commercial dairy farms in central New York has emphasized a budgetary evaluation of alternatives for a medium size farm. Doubling the size of the dairy from 18 to 36 cows without any change in practices or rates of crop and livestock production, but providing for the additional labor and capital improvements, result in little change in labor income. Improved crop, pasture feeding and breeding practices applied to the existing 18-cow dairy could improve labor income from \$2,143 to \$6,815. If these improved practices were used with a 36-cow herd, labor income would rise to \$7,800. A report on the study is nearly complete.

A study of relation of milk production per cow to costs and returns on dairy farms in southern Wisconsin is designed to ascertain the quantity, quality and costs of inputs used in producing milk, to estimate the most profitable level of milk production per cow under various prices of milk and costs for input factors, and to appraise the opportunities to increase the size of the farm business and net farm income on dairy farms through increasing production per cow. Data are being analyzed to develop estimates of inputs needed for various levels of output. Comparisons are being made among various groups of herds in the sample and among years for herds that varied in production per cow during the period of record. Comparison of these optimum farm plans with usual systems of farming will indicate the profitableness of increasing the size of the farm business through increasing milk production per cow.



Preliminary results from a special analysis of supplemental enterprises on grain farms in North Dakota indicate that substantial additions to family income may be made with milk cows providing the dairy enterprise is organized so as not to compete for labor with wheat and other grain crops during seeding and harvest seasons. A crucial factor in the economics of dairying on Northern Plains grain farms is the opportunity cost of labor used in dairying. If the dairy enterprise uses labor at a time when no other employment is available and low costs are attributed to labor, the dairy enterprise shows substantial margins of profit. But it generally will not be profitable if it has to compete with wheat and other grain crops.

Plans: A broad program of research on needed adjustments by farming areas will be continued as a major part of the work. Present area studies will be completed as rapidly as possible and new area studies or additional phases of going studies will be initiated. Added emphasis to the program will be given to those phases of present or new projects pointing toward aggregate area, regional and national impacts of adjustments on farms. An early goal in the farm adjustments research program is to appraise results of going studies, as they become available, so that broad regional adjustments in the use of farm resources may be specified for the northern dairy region, the cotton region, and the wheat region.

#### Publications

The Changing Picture of Farming in Southeastern Minnesota. G. A. Pond and T. A. Nodland. Minn. Agri. Expt. Sta. Bul. 446. January 1958.

Beef Cow Herds for the Production of Feeder Calves in Indiana. M. R. Janssen and H. Mayo. Ind. Agr. Ext. Ser. July 1958.

Analysis of Grassland Farming in Northeastern Pennsylvania. K. H. Myers. Pa. Agr. Expt. Sta. Bul. 627. Dec. 1957.

Sample Contracts for Raising Dairy Herd Replacements. S. B. Weeks, et al. N. H. Univ. Expt. Cir. 342. Dec. 1957.

Economic Considerations in the Production of Short, Medium and Long Grain Rice In Northeast Arkansas. T. Mullins. Agr. Expt. Sta. Rpt., Series 3. Oct. 1957.

Physical and Economic Characteristics that Limit Adjustments on Full-time Medium-sized Farms in the Piedmont Area of South Carolina. T. A. Burch and C. P. Butler. S. C. Agr. Expt. Sta. Bul. 453. March 1958.

Economic Analysis of Conservation Farming. W. C. McArthur and J. R. Carreker. Ga. Agr. Expt. Sta. Bul. N.S. 51. March 1958.

Pastures and Pasture Practices. H. A. Henderson. Tenn. Agr. Expt. Sta. Bul. 272. Sept. 1957.



Publications (continued)

Silage Making Costs and Practices. W. F. Gregory. Ala. Agr. Expt. Sta. Bul. 310. Dec. 1957.

Economics of Adjusting to Drought on Eastern Oregon Cattle Ranches. J. R. Gray and C. V. Plath. Oreg. Agr. Expt. Sta. Misc. Paper 48. Sept. 1957.

Production and Production Requirements of Crops, Blackland and Grand Prairies. A. C. Magee and R. H. Rogers. Tex. Agr. Expt. Sta. MP-224. Sept. 1957.

Farm Adjustments and Earnings Under 1955 Cotton Acreage Allotments - No. 2. Small Grape-Cotton Farms on the San Joaquin Valley Eastside. D. C. Athanassatos and T. R. Hedges. Calif. Agr. Expt. Sta. Mimeo. Rpt. 194. May 1957.

Economic Possibilities of Seeding Wheatland to Grass in Eastern Colorado. H. G. Sitler. ARS 43-64. Feb. 1958

Wheat Production Trends-Problems-Programs-Opportunities for Adjustment. C. W. Nauheim, W. R. Bailey and Della Merrick. Agr. Inf. Bul. 179. March 1958.

Farm Adjustments and Earnings Under 1955 Cotton Acreage Allotments. No. 3. San Joaquin Valley Eastside Cotton Farms. D. D. Caton, T. R. Hedges, and W. N. Schaller. Calif. Agr. Expt. Sta. Mimeo. Rpt. 202. May 1958.

Alternative Cropping Systems for Southwestern Nebraska - A Comparison of Net Returns from Various Crop Combinations. R. D. Vlasin and A. W. Epp. Nebr. Agr. Expt. Sta. SB 443. 1958.

Labor Requirements as Related to Dairy Herd Size. H. J. Aune and L. M. Day. Minn. Farm Business Notes. Feb. 1958.

How Profitable are Beef Herds? M. R. Janssen, L. S. Robertson and J. E. Matsen. Econ. and Mktg. Info. for Ind. Farmers. Jan. 1958.

Response of the Farm Production Unit as a Whole to Prices. J. R. Tompkin. Ann. Meet. Amer. Farm Econ. Assoc., Winnipeg, Canada. Aug. 1958.

Problems in Adjusting Land Use and Production on Great Plains Farms. M. L. Upchurch. Proceedings, Great Plains Agr. Council. July 1958.

## 2. Farm Program Analyses

ARS-FE

Problem: An understanding of the economic impacts of farm programs and of the program provisions required to achieve given economic results often requires a rapid and general appraisal of existing or proposed programs. The purpose of farm program analysis is to provide economic information required for appraisal of effects of farm programs relating to farm incomes, adjustments of production to market outlets, and conservation.

Program: This is a continuing program which includes service work for agencies responsible for administration of farm programs as well as independent and cooperative research with State agr. expt. stas. and other agencies of the Department, and includes the interpretation of findings from research on adjustments in farming and other studies as they relate to farm programs, and involves less than 1 professional Federal man-year annually.

Progress: A part of the work during the year included an economic appraisal, in cooperation with AMS and CSS, of an expanded Conservation Reserve Program for use by the Office of the Secretary and CSS. The objective of the proposed expanded program would be to retire enough cropland and other resources from farm use, over a 6-year period, to accomplish an approximate balance between farm production and market outlets at prices considered reasonably acceptable to farmers and make possible the discontinuation of acreage allotments, marketing quotas, and export subsidies, reduction of carry-over stocks, and only limited Government price support. It was estimated that 55-60 million acres of cropland, including the 28 million acres in the Soil Bank in 1957, would need to be placed in the program during the 1960-65 period. These estimates take into account probable changes in crop yields and market outlets at assumed prices for farm products by 1965. The total acreage in wheat and feed grains would need to be reduced by about 13% from 1957 levels. Government costs of the program were compared with those of present programs.

A study of food production with present crop and livestock patterns and with increased emphasis on direct food crops was made at the request of those concerned with defense planning. The study shows that it would be possible for American farms to support twice as many people with nutritionally adequate diets from land now used to produce food for domestic consumption by shifting to a production and consumption pattern containing additional direct food crops in place of livestock products. Or, if it became necessary, our present population could be fed from half as many acres as are now used. The computations also illustrate changes in food consumption to utilize production from land now moving into stock accumulations or export uses. Net additions to stocks of farm products represented production from about 14 million acres a year during the 1953-57 period.

A study of the effects in selected areas of the 1957 Conservation Reserve Program of the Soil Bank was completed. This study indicated that the Conservation Reserve Program has had relatively little effect



on dairy production, that much of the land contracted was about as good as non-participating cropland, but that many participants were taking advantage of the program to help them retire or to secure off-farm employment. It has been used by State and county officials of the CSS and FES in educational work with farmers designed to illustrate the circumstances under which participation in the Conservation Reserve would be advantageous to individual farmers. It also was used by the CSS at Congressional hearings on the 1959 Soil Bank Program and at regional meetings with State Agricultural Stabilization and Conservation Committee members on plans for the 1959 Soil Bank Program. Special reports on findings from studies in local areas were prepared for administrative use.

A detailed report on the findings from a study of the effects of acreage allotment programs for wheat, corn, cotton, and rice in selected areas was completed and published.

Plans: Studies of the 1958 and 1959 Soil Bank Programs, including a study of the experimental program under which farmers submitted bids for entering land in the Soil Bank, are being initiated in selected areas of several States. Analyses of the impacts of alternative farm programs will be incorporated in several area adjustment studies. Service work will be continued at about the same level.

#### Publications

The Conservation Reserve Program of the Soil Bank, Effects in Selected Areas. Agr. Info. Bul. No. 185. March 1958.

Effects of Acreage-Allotment Programs, 1954-55, A Detailed Analysis for Selected Crops and Areas. ARS 43-47. Dec. 1957.

An Economic Appraisal of the Conservation Program in Area III B, Upper Coastal Plain of South Carolina. S.C. Agr. Expt. Sta. and FE. C. P. Butler and W. J. Lanham. Mimeo. Rpt. 135. Feb. 1958.

### 3. Economics of Farm Structures

ARS-FE

Problem: To develop information on alternative types of farm structures and layout to help farmers reduce their investment and operating cost and to develop more efficient work methods in various types of structures.

Program: A continuing long-term program including economic studies of alternative structures and layouts in different farm situations; changes in types of structures on farms, and changes in practices and in methods of materials handling within farm buildings, in cooperation with State agr. expt. stas. and AE, and involving about 1.5 professional Federal man-years annually.

Progress: Work on the economics of farm service buildings on Maryland dairy farms is underway. Preliminary results indicate that loose housing-milking parlor combinations require considerably less chore



labor than do the conventional stanchion-type barns for herds of 35 cows or more. Investments per cow vary widely in each system but normally are somewhat lower for the loose housing setup. Some farmers with stanchion barns have converted to loose-housing and many others are considering such a shift. Further analysis will be completed during the year to help farmers appraise the possible effects of alternative decisions in adopting or modifying dairy structures.

Plans: Plans include continuation of the projects listed. Consideration will also be given to establishing and keeping up to date several statistical series bearing on farm buildings and structures.

#### Publications

Bull: Handling of Milk--Its Economy to Farmers. M. S. Parsons. USDA ARS 43-71.. June 1958.

#### 4. Economics of Feed Utilization

ARS-FE

Problem: To determine effects of new feeding and livestock management techniques on feeding efficiency and marginal rates of substitution between feeds; to ascertain effects of different rates of feeding on quantity and quality of output; and to develop and maintain a series of national and regional statistics pertaining to the production and consumption of feeds and to the feed-livestock balance.

Program: A continuing long-time project including studies on the relation between feed, livestock and food; changes in livestock production and productivity with projected changes to 1975; economic analysis for determining minimum cost feed mixtures; and economic evaluation of forage production and utilization, carried on in cooperation with the New Hampshire and Pennsylvania Agr. Expt. Stas. and AMS, and involving approximately 2 professional Federal man-years annually.

Progress: A revision of Production Res. Rpt. No. 21 will be made at 5-year intervals. The analysis in the study of changes in livestock production and productivity with projected changes to 1975 has been completed, and a manuscript is being drafted.

Analyses of data obtained for the economic evaluation of forage production and utilization in New Hampshire are proceeding to relate the level of management to the quantity of forage produced. Definite relationships are evident on the farms in the study between the rate of milk production and the quantity and quality of pasture produced.

#### Publications

Consumption of Feed by Livestock, 1909-56. R. D. Jennings. USDA Prod. Res. Rpt. No. 21. June 1958.



Publications (continued)

Animal Units of Livestock Fed Annually, 1909-57. E. F. Hodges. USDA Statis. Bul. 235. Aug. 1958.

Livestock-Production Units, Annual 1909-56. E. F. Hodges. USDA ARS 43-80. Aug. 1958.

A Least-Cost Broiler Feed Formula Method of Derivation. R. F. Hutton, G. A. King, and R. V. Boucher. USDA Res. Rpt. No. 20. May 1958.

PROPOSALS FOR  
COMMITTEE CONSIDERATION

1. Modernization of National Cooperative Dairy Herd Improvement and Sire-Proving Programs

The use of newly developed electronic data processing equipment will make it possible to compile and analyze DHIA data more completely, and will permit keeping sire proving on schedule with the sire data being supplied by the States. The program should be expanded to make use of newer data processing equipment now available.

While conventional IBM equipment is now in use, its limited speed and capacity make it impossible to keep up with incoming data. Adoption of the new tape computing equipment would make it possible to keep the sire proving work up-to-date, and would permit further research of dairy management problems of value to the dairy farmer. With 27% of the national dairy herd artificially inseminated annually and increasing each year, it is doubly important that information on sires be readily available to sire selection committees of the artificial breeding studs in the States. (1/19)

2. Breeding for Improvement in Milk Composition, Feed Efficiency and Rate of Milking

The dairymen of the future needs information in order to fill the consumers' need for the most nutritious and palatable drink possible and if that milk is to be produced with maximum efficiency. Research in breeding should be expanded on improving milk composition, feed efficiency and rate of milking of dairy cattle.

Dairymen throughout the Nation are faced with changing market demands. Present trends in the fluid milk market indicate a consumer interest and need for milk with a maximum protein content without a maximum of fat. Limited research suggests that protein and all the solids-not-fat may be increased by breeding without corresponding increases in fat percentage. Immediate expansion of this research through vigorous support of the existing inter-state cooperative study will obtain the facts needed to substantiate or refute this possibility.



The development of dairy cattle which produce with increased feed efficiency and rate of milking is a means by which labor and feed costs can be materially reduced. Investigations on feed efficiency with other types of livestock have shown a genetic basis for differences between individuals in this characteristic and effort to improve it in breeding animals have resulted in progress. Limited data with dairy cattle suggest genetic differences in feed efficiency. Confirmation of this suggestion is needed as well as extensive information on the possibilities of using feed efficiency as a selection tool. There is no information available regarding the inherited ability of cattle to utilize roughage for milk production as compared to using roughage plus grain. If real genetic differences exist in this ability, the development of cattle for utilizing roughage would add real impetus to the grassland programs of the country.

There is definite evidence that rate of milking is influenced by genetic as well as environmental causes. Rapid and practical methods of measuring this characteristic have not been developed. When additional research has accomplished this, it will be possible to ascertain the extent to which rate of milking can be improved by breeding. Such improvement would result in real savings in labor and costs to dairy-men. Despite rapid milking procedures in dairy herd management, most dairymen spend an average of 4-6 minutes in milking time per cow. (New)

### 3. Reduce Time, Labor and Feed Wastage in Dairy Herd Management

The trend toward larger dairy herds, the rising costs and scarcity of competent hired labor, and other adjustment pressures make it urgent that information be developed to make the industry more efficient. Research should be expanded to assist in lowering production costs and in reducing the voluminous and arduous labor requirements. Particular emphasis should be placed on studies of individual versus group feeding of cows, automatic feeding methods including self feeding, frequency of feeding, bulk feeding, feeding procedures and equipment especially adapted to milking parlors and management practices affecting milking time per cow including comparisons of milking parlor arrangements and modifications of stanchion barns. The effect of the management methods on the feed intake and milk production of the cows should be ascertained as well as the possible savings in labor and equipment utilization and feed wastage.

Present information shows a requirement of 62 man-hours of labor per \$100 worth of milk in 1950--compared with 23 man-hours for corn and 11 for wheat per \$100 worth of product. Outlook Charts for 1958 show that the output per man-hour for milk cows increased only 89% from 1910 to 1956, while for feed grains it increased 349%.

The cost of feed is approximately one-half the total cost of milk production. Reduction in feed wastage through handling would contribute effectively to reductions in these costs. The growing acceptance in all parts of the country of loose housing and milking parlor systems has created considerable need for developing efficient methods adaptable



to these systems. In addition those dairymen for whom the conventional stanchion methods are still profitable need the benefit of economically feasible automatic feeding or self-feeding procedures as well as increased efficiency in milk handling. Even though modern equipment often permits and even requires larger dairy units, the development of more efficient feed and milk handling methods should be directed to the benefit of those dairymen who are not in the position to enlarge their operations but who need increased efficiency in the enterprise they have. The problem is national in scope, involving dairymen in all parts of the country. It is essentially applied in character. (6/19)

#### 4. Factors Affecting Consumption of Feed and Forages

The usefulness of forages as an economical feed source is sometimes limited by inadequate consumption. Highly digestible feeds are of little value or their value is reduced if they are unpalatable and consumed in insufficient quantities to meet animal requirements. Research should be initiated on factors affecting palatability and consumption of forage feeds to determine the relationship of digestibility, chemical composition, physical nature or other nutritional values to voluntary consumption of forages. Work on the effects of season, stage of maturity at harvest, preservation or storage procedures and level of soil fertility on nutritional values, including net energy, and on consumption should receive increased emphasis.

Increased efficiency of utilization of pelleted rations of some types has been demonstrated but the manner in which the pelleting process facilitates this increase is not known. Information on the effects of the individual physical forces (heat, pressure, etc.) involved in pelleting might contribute to a solution of this problem. Reports have suggested more efficient utilization resulting from increased frequencies of feeding with dairy cattle. Frequent feeding versus the conventional twice a day or ad libitum procedures would test the practicability of such a program with cattle. An index of the comparative value of feeds which considers not only nutritional values (total digestible nutrients, digestible energy or net energy) but also variations in consumption should be developed from these data.

This problem is of importance to all livestock producers who depend on grassland production as a major source of nutrients for livestock. Present emphasis on grassland farming and on the production and utilization of early maturing crops produced under high fertilization and involving expensive harvesting machinery and storage facilities may require more expense than the returns in terms of animal production justify unless maximum consumption and nutritional improvement of the crops produced are attained. The work proposed will provide basic information on factors affecting consumption of forages. This information can be applied to the development of more realistic feed evaluations which could be utilized as a basis for improvement in efficiency of crop and animal production. (new)



5. Rumen Metabolism and Its Relation to Lactation

The effects of processing and physical state of feeds on rumen metabolite production, factors affecting the absorption and utilization of rumen metabolites and the effects of rumen metabolism on energy evaluation of feeds should be determined. Research on rumen metabolism, factors affecting rumen metabolism and the utilization of rumen metabolites for productive purposes should be expanded. A more detailed examination of mammary gland metabolism in relation to level of production and milk composition and to rumen metabolism would be an integral part of this research.

The relationship of variations in rumen metabolism and the varying proportions of acids produced by rumen metabolism to level and persistency of milk production and fat percentage of milk is only incompletely understood. The productive energy values assigned to feeds may also be a reflection of variations in the production and absorption of acetic acid produced by rumen fermentation of feeds. The physical nature of feeds, processing of feeds and ration composition may also affect milk composition, presumably through an effect on rumen metabolism. (2/19)

6. Chemistry and Physiology of Hormones to Increase Efficiency of Dairy Production

The use of hormones to increase efficiency of livestock production is seriously hampered by lack of adequate methods for determining concentrations of hormones in tissues, blood and body fluids. Similarly, lack of information on the physiological action of hormones limits the use of hormones to control reproductive activity and correct reproductive abnormalities, and to stimulate lactation, growth and other productive functions. Studies on the metabolism and excretion of hormones and their action on various tissues using isotopes and other techniques and studies on rates of secretion in relation to problems of reproduction, lactation, etc., are needed to form the basis of a fundamental understanding of the action of the hormones. On the basis of these findings continue to explore new uses for hormones to increase production. Physiological and chemical work with hormones should be expanded to extend the usefulness of these materials for increasing the efficiency of production of all classes of livestock.

This is a problem of national importance. The potential use of hormones to increase production is illustrated by the recently developed and widespread use of estrogens in fattening of cattle in which 15 to 20% increases in efficiency are commonly observed. Losses from reproductive failure are estimated to cost dairy farmers alone \$250,000,000 annually. If 10% of these losses could be prevented or corrected by the use of hormones, a not insignificant saving to dairy farmers alone would be effected. This problem exists with all classes of livestock. The proposed use of thyroid materials to increase milk production,



while having limitations, has potential usefulness. Basic research on the chemistry and physiology of hormones is; therefore, urgently needed to fully explore and utilize the potential of hormones for increasing efficiency of production. (9/19)

7. Producing Quality Beef from Dairy Animals and Maximizing Beef and Milk Production of Dual-Purpose Cattle

Improvement in the general meat supply could result from greater attention to preparing animals of dairy origin for marketing for slaughter. Research on producing quality beef from dairy animals, including studies of the problems and economic feasibility of raising dairy steers to typical beef market weights rather than marketing at bob or veal stages, and studies on improving quality of beef from older animals should be initiated. Approximately one-third of the beef now produced in this country comes from dairy animals, indicating the present importance of the problem which will probably become more acute as beef requirements increase with population increases. A part of the proposed study would include the use of beef bulls upon dairy herd members whose offspring are not wanted as herd replacements to permit comparing beef production of dairy, beef x dairy, and beef type animals. Applying beef cattle management practices to the raising of dairy type animals for beef needs to be studied. Roughage to concentrate ratios will be varied to control levels of energy intake when completely mixed and/or pelleted rations are offered to such animals. (New)

8. Development of Effective and Safe Methods of Controlling Flies, Grubs, Ticks, and Lice Affecting Dairy Animals

No area in the United States is free from bloodsucking flies, mosquitoes, ticks, and lice that attack dairy cattle. Research should be expanded to develop safe and effective insecticides, repellents, and new formulations that will control various insects, especially resistant forms, on dairy animals and on feed and forage and not create residues in milk. Special studies on the fate of chemicals on the animal's skin should be undertaken. Research is needed to develop other means of control, such as biological agents, attractants, or barnyard management, especially to combat the vicious stable fly (dog fly) for which control measures are inadequate.

Insects reduce milk yields from 5 to 20% and cause annual losses estimated to exceed \$200 million. New non-residue forming and effective insecticides and other control measures will reduce losses caused by insects, improve quality and production, and increase profits to the dairyman while reducing costs to the consumer. (3/19)

9. Insect Vectors of Animal Diseases

Diseases of dairy animals are prevalent throughout the United States. Some are endemic in certain regions, such as anaplasmosis in the South and West. Studies should be expanded to determine the role that



various species of ticks and blood-sucking flies play in the harboring and transmission of anaplasmosis, encephalitis, anthrax, and other diseases suspected of being arthropod-borne. The role of filth insects, such as house flies, in relation to certain diseases needs study. Research should be expanded on the biology, behavior and incidence of proved or suspected insect vectors with the aim of developing new control techniques and/or making more efficient use of current ones.

The losses caused by insect-borne diseases amount to millions of dollars annually and research to gain an understanding of the complex problem of disease transmission by insects will lead to better ways of controlling them and thus reduce the incidence of animal diseases with profit to the growers. (7/19)

10. Influence of Environmental Factors on Dairy Cattle

Growth, health, fertility, production, feed consumption, and heat dissipation of dairy cattle are influenced by environmental factors such as temperature, humidity, wind, rain, radiation and light. Research to determine the nature and extent of these influences and their complicated interrelationships, particularly under conditions of stress, should be expanded to accelerate obtaining the basic data needed for design of shelters that will provide optimum environmental conditions in the most economical manner.

Preliminary laboratory studies and field experience have shown that both production and production efficiency decline at temperatures below freezing and above 75° F. The multiplicity of climatic variables throughout the country, combined with the interacting effects of such other factors as breed, feeding practices, size and stage of production, make these studies extremely complex and time-consuming.

The proposed research is basic in character, aimed at establishing the relationships of radiation, convection and evaporation in dissipation of heat from the animal; determining the conditions which provide optimum environment; and applying this basic information to developing methods and equipment of providing the optimum economical environment. The latter includes emphasis on hot weather shelters for both hot-humid and hot-dry climates. (19/19)

11. Improved Harvesting, Handling, Storage and Feeding of Forage as Hay and Silage

New and improved procedures for harvesting, handling and storing forage in all forms including pellets will help supply high quality meat and dairy products to the consumer at a reasonable cost while reducing farm production costs and maintaining farm income. High labor costs accentuate the need to devise methods of harvesting and storing forage crops that are adaptable to all types of farming. Research should be expanded to determine the bacteriological and chemical changes taking place in forage put up as silage or as dry hay whether in the long,



chopped, baled, pelleted or wafer form, the effect of those changes on the nutritive value of the forage and the economic value of the different methods with different classes of farms.

This research applies to the production of approximately 75 million acres of hay and 10 million acres harvested as silage of all types. Total preventable loss to the hay crop in 1954 was estimated at 21% and silage losses have been estimated to vary from 10 to 20%. Both basic and applied research are required to determine the factors involved in these losses and means of reducing them.

Pelleting is a recently developed method of treating forage crops and offers prospective nutritional and handling benefits of important economic significance. Information is needed on the best methods and equipment for harvesting, processing and handling the pellets as well as their nutritional qualities as feed. (8/19)

## 12. Mineral Interrelationships in Plant and Animal Nutrition

The discovery of the obscure factors involved in such endemic diseases as molybdenum toxicity in cattle, congenital anomalies in lambs and calves, bone maladies and other nutritional problems apparently related to soil conditions will prevent appreciable losses and increase animal productivity on many soils. Nutrition research involving basic biochemical and physiological studies should be expanded to broaden our knowledge of the mechanism by which mineral interrelations affect the animal's utilization of mineral and other nutrients from food, feeds and forages grown under specific soil conditions with profound effect on the growth, health and reproductivity of domestic animals. Such knowledge will broaden the basis for soil classification with important implications in human nutrition.

The problem with animals is national in scope. Recent discoveries of apparent imbalances in the cation-anion relationship in forages suggest this to be one factor involved in forages of low nutritive quality in widely separated areas of the United States. Faulty bone formation, apparently due to poor phosphorus metabolism in fetuses are probably due to the interference of some mineral element present in excess in the forage. Interrelationships among copper, molybdenum and sulfur in forages must be clarified before adequate and proper recommendations can be made concerning certain diseases in range cattle. The importance of such knowledge is indicated by such interrelationships known or suspected as iron and copper hemoglobin formation, calcium and zinc in swine parakeratosis, selenium and vitamin E, magnesium and excessive calcification. At least 1,000,000 acres of western range land is associated with troubles involving mineral interrelationships. The area in eastern U. S. where potential imbalances could occur under intensive fertilization programs cannot be estimated, but must be substantial. In some areas up to 7 to 10% of the lamb or calf crop is lost due to obscure factors probably associated with faulty mineral metabolism.



The research proposed here is basic to numerous soil-nutritional programs now under way in the U.S. Laboratory investigations using small animals followed by a limited number of large animal experiments in cooperation with the State agr. expt. stas. will be conducted. (11/19)

13. Infectious Diseases of Dairy Cattle - Existing Work

Prevention, control, or eradication of infectious diseases is necessary for efficient production of livestock, and are dependent upon and limited by the development of knowledge through research. Expansion of basic and applied research is needed to (a) develop better procedures of isolation, propagation, characterization, preservation, and destruction of etiological agents associated with, (b) develop more specific test agents and methods for diagnoses of, (c) develop immunizing agents and determine feasibility of their use in the prevention of, (d) develop new treatments and determine their usefulness in the control of, and (e) develop additional information on the pathogenesis, reservoir of infection, methods of transmission, pathological processes and epizootiology of, the following diseases of dairy cattle: mastitis, leptospirosis, vibriosis, paratuberculosis (Johne's Diseases), vesicular stomatitis, and mucosal diseases (Iowa mucosal, virus diarrhea, winter dysentery, malignant catarrhal fever, and rhinotracheitis).

It has been conservatively estimated that this group of diseases causes losses of \$400,000,000 annually to the dairy industry. Mastitis is the most costly of all diseases. Leptospirosis is very widespread and causes severe losses in milk production, meat, and deaths. Limited basic knowledge on each of these diseases is responsible for their ineffective control. Vibriosis is responsible for approximately 40% of sterility of dairy cattle in the United States. There are no accurate estimates on the prevalence of Johne's disease in this country, but it has become a major problem to the cattle industry in Great Britain and European countries where there are few national disease control programs to keep them aware of its seriousness. The recently recognized mucosal disease complex expresses itself as enteric or respiratory symptoms and every effort should be made to develop information that can be used to prevent them from becoming enzootic.

14. Infectious Diseases of Dairy Cattle - New Work

Prevention, control, or eradication of infectious diseases is necessary for efficient production of livestock, and are dependent upon and limited by the development of knowledge through research. Initiation of basic and applied research is needed to (a) develop better procedures of isolation, propagation, characterization, preservation, and destruction of etiological agents associated with, (b) develop more specific test agents and methods for diagnoses of, (c) develop immunizing agents and determine feasibility of their use in the prevention of, (d) develop new treatments and determine their usefulness in the control of, and (e) develop additional information on the pathogenesis, reservoir of infection, methods of transmission, pathological processes and epizootiology of the following diseases of dairy cattle: shipping fever,



infertility, calf scours, Q fever, mycotic diseases (ringworm, actinomycosis, toxicosis, coccidiomycosis, blastomycosis, and histoplasmosis), and miscellaneous diseases (foot rot, infectious keratitis, blackleg, malignant edema, anthrax, calf diphtheria and red water disease).

It is difficult to estimate the annual losses to the dairy industry caused by this group of diseases, however those due to shipping fever, infertility, and calf scours are considerable. Although shipping fever has plagued the cattle industry for years, no effective preventive or therapeutic measures have been developed. The cause or causes of approximately 60% of the infertility of cattle are unknown. Calf scours are responsible for the majority of the loss associated with young calves, and the partially effective methods of prevention and treatment are costly. Knowledge is very limited concerning prevention, control and treatment of all the mycotic infections. Miscellaneous diseases collectively cause serious losses to the industry on a herd, locality, or regional basis. The most significant of these are foot-rot, infectious keratitis, blackleg, and anthrax. It is obvious that research cannot be done concurrently on all miscellaneous diseases, but it can be done on one or more continuously.

#### 15. Non-Infectious Diseases of Dairy Cattle

Prevention of losses caused by non-infectious diseases of dairy cattle contributes to profitable dairying which is closely integrated with a sound national economy. Both basic and applied research must be expanded and intensified: (a) to determine the physiopathological conditions produced by acute indigestion and bloat of dairy cattle, particularly when pastured or fed green legumes so as to have a foundation for the scientific approach toward their prevention; (b) to determine the acute and chronic toxicity of promising new insecticides developed for use on dairy animals and on crops which are fed to them so as to know the safe amounts to use and the distinguishing diagnostic symptoms and lesions produced by them, and do basic research work on toxicology of heavy metals and treatment thereof; (c) and to determine the role of a number of known and suspected poisonous plants as the direct and indirect causes of dairy cattle and calf losses, and on the effects of some herbicides and fertilization practices on making some plants poisonous.

Cattle losses due to bloat, chemical poisoning, ketosis or acetonemia, poisonous plants, urinary calculi, grass and wheat tetany, and tumors have been estimated at sixty-two million dollars annually. Bloat of dairy cattle is common and often a deterrent to profitable feeding and pasturing of green legumes. The increased use of agricultural chemicals, especially insecticides, herbicides, fungicides, and fertilizers, has directed attention to possible poisoning of dairy cattle. Many insecticides are poisonous for dairy cattle and calves when not properly used. Plants are often suspected as being the cause of sudden, unusual sickness or death of dairy cattle. There are a number of poisonous plants



in the Western States but little is known about their significance in other parts of the United States. The toxic fraction of many poisonous plants and their antidotes have not been found, and knowledge of controlling such plants is limited.

16. Parasites of Dairy Cattle - New Work

Specific information on all phases of bovine parasitism is indispensable to the development of rational measures of prevention, control, and eradication for the protection of the dairy industry against losses. Initiation of basic research is necessary to develop (a) procedures for destruction, propagation, characterization, preservation, and isolation of the various parasites in all of their stages, (b) specific test agents and methods for diagnosis, (c) immunizing agents and feasible uses thereof in prevention and control, (d) new treatments and methods of chemical and biotic control, and (e) information on pathogenesis, reservoirs of infection, internal parasites as vectors and incitants of disease, pathobiological processes including influence on feed utilization and growth, modes of transmission, host specificity, and epizootiology, of the following parasitic diseases of cattle: fluke diseases; babesiosis; theileriosis; gonderiosis; trypanosomiasis; toxoplasmosis; sarcosporidiosis; cystic tapeworms; parasitic skin diseases, including mange, tick infestations, and other external parasitic conditions.

Parasites, both internal and external produce detrimental effects to cattle. Preventable losses have recently been estimated at the equivalent of 5 to 12% of production. One of the parasitic diseases on which no work is being done is fluke disease, which costs producers more than 3.5 million dollars annually. Cystic tapeworms are responsible for condemnations of affected carcasses and parts, and two of these parasites constitute a serious hazard to human health. Some conditions caused by external parasites such as demodectic mange are estimated to cause as great losses as the two preceding types of parasitism combined. Numerous devastating protozoal diseases, common in foreign countries, have not yet become established in this country; the introduction of which could be disastrous for the dairy industry, unless we are prepared to cope with them.

17. Parasites of Dairy Cattle - Existing Work

The need for more specific information about each of the wide variety of parasites of cattle is shown by the heavy losses encountered annually by the dairy industry. Effective control measures can be realized only by expanding research to develop (a) better procedures for destruction, propagation, characterization, preservation, and isolation of the various stages, (b) specific test agents and more effective methods for diagnosis, (c) immunizing agents and feasible uses thereof in prevention and control, (d) new treatments and better methods of chemical and biotic control, (e) basic information on pathogenesis, reservoirs of infection, internal parasites as vectors and incitants of disease, pathological processes, influences on feed utilization and growth, modes of transmission, host specificity, epizootiology,



occurrence, (f) improved systems of eradication and prevention, and (g) improved methods of documentation as research tools, and dissemination of information concerning the following: lungworms, gastrointestinal nematodes; nodular worms; stomach worms, tapeworms; intestinal threadworms; coccidia; trichomonas; and miscellaneous internal parasites; scabies mites, ticks and other external parasites.

Parasites are widespread in cattle in practically all parts of the country. Severe infections may cause scours, emaciation, general debility and marked unthriftiness. Subclinical parasitism is responsible for slower growth, decreased production, and uneconomical utilization of feed. There are no entirely effective control measures for more than 50% of the parasites that affect dairy cattle, and measures that are in use for the others do not meet practical requirements. Many highly important biological and eipzootiological aspects of parasitisms remain to be elucidated. Parasites are becoming more prevalent and a greater potential threat to profitable production now than formerly, because of increases in grassland conversion, irrigation for pastures, greater stock concentration, and increased animal movement. Some parasites formerly thought to be restricted to swine and to sheep are now known to affect the health of cattle as well. To meet the increasing threat of parasitism, it is essential to develop more effective means for circumventing these pests.

#### 18. Weed and Brush Control in Grazing Lands

The use of herbicides and improved management practices of weed control on pastures show reduced losses from weeds in terms of quality and quantity of dairy products produced. Research to develop basic principles and practices for weed control in pastures should be expanded.

Weeds and brush reduce the production and quality of forage on most of the 103 million acres of grassland pasture and grazing land in the eastern half of the U. S. Field studies have shown that control of brush results in 3 to 8 times as much forage as is available in untreated areas. Control methods now available are being adopted on farms and ranches at an increasing rate but the cause of extreme variability in response of individual trees and perennial weeds and the frequent partial failures of chemical control are still largely a mystery. Losses also come from browsing brush and poisonous weeds. Total annual losses from poisonous plants are estimated to be \$3.7 million. In addition, are the losses to farmers from "off-flavors" in milk and other products. There was a \$3 million loss to farmers in one State alone because of milk rejected for off-flavors caused by wild onion, bitterweed, and others. Methods of killing such brush and weeds must be perfected. Also, research is urgently needed with new herbicides that promise selective control of weeds in the establishment of grasses and legumes in improved pastures. (New)



19. Forage Microclimatology and Management

Forage management regimes designed to provide as nearly as possible the optimum requirements of improved legumes and grasses for various climate-soil areas would reduce the hazards and costs of establishing and maintaining productive stands of good quality forages and would promote increased efficiency in operation for both the producer and consumer of pasture, hay and silage crops. Research on various facets of microclimate as related to forage plant management should be expanded to study the effect of kind, time, duration and intensity of precipitation; air, soil and plant tissue temperatures; wind, frost, humidity and evaporation; quantity and quality of light; physical and chemical and biological properties of soil; as well as transitory influences of insects, rodents, rabbits and larger animals; grazing intensity; and frequency of cutting on establishment, growth response, forage yield and composition, and stand persistence of adapted superior varieties of legumes and grasses. Results from such research will aid breeders in developing varieties adapted to special climate problem areas, and will be of fundamental importance in formulating management practices designed to modify for given locations those microclimates which are most damaging to forage plants. Under summer field conditions white clover stolons exposed to full sunlight as result of frequent and close grazing show internal temperatures  $30^{\circ}$  to  $40^{\circ}$  higher than the temperature of adjacent stolons protected by a canopy of green growing leaves. The influence of such temperature differences on the physiology of the plant and on forage yield and stand longevity are not understood. There is also lack of knowledge concerning the interaction of various components of environment in relation to relative establishment, growth, and persistence abilities of legumes and grasses grown alone and in various associations. (New)



## II. UTILIZATION RESEARCH

### A. CHEESE

#### 1. New Labor-Saving Method for Making Cheddar Cheese

ARS-EU

Problem: The development of improved methods for manufacturing Cheddar cheese from pasteurized milk.

Program: A continuing program of research on a pilot plant scale for the improvement of existing procedures and the development of new labor-saving techniques for the cheese manufacturing industry, carried on in Washington, involving 3 professional Federal man-years annually.

Progress: A new labor-saving method for making Cheddar cheese of good quality without the conventional, tedious and labor-requiring matting or cheddaring procedure has been developed and reported to the cheese industry. With the new method, the conventional 7-hour method is followed, except during the period from draining the whey to milling the curd. At the usual time for draining off the whey, the mixture of curd and whey is pumped into a curd-retaining form; the whey is drained off; and the curd is allowed to form one large block. Later the curd is milled and handled in the conventional manner. The hand labor involved in repeatedly handling and turning many small blocks of curd in the conventional method is eliminated. Cheese made with this method has had the same general characteristics and composition as cheese made with the conventional method. It has a typical Cheddar cheese flavor, a few mechanical openings, and a firm pliable body.

Plans: Effects of variations in time, temperature, procedures of draining the whey, and size of curd block, etc., on the flavor, body, and texture of the cheese will be continued.

#### Publications

Labor-Saving Methods for Making Cheddar Cheese. H. E. Walter, Presented at meeting of Indiana Cheesemakers, Purdue Univ., Lafayette, Ind., Nov. 1957.

Labor-Saving Methods for Making Cheddar Cheese. H. E. Walter, A. M. Sadler, and C. D. Mitchell. J. Dairy Sci. 41. 1958.

A New Labor-Saving Method for Making Cheddar Cheese. R. P. Tittsler. Proc. 27th Annual Inst. of Dairying. State College of Washington, Pullman, Wash. March 10-13, 1958.

Effect of Salt on Acid Development in Cheddar Cheese. H. E. Walter, A. M. Sadler, C. D. Mitchell, and R. E. Hargrove. J. Dairy Sci. 41(5) (Abst.). 1958.



2. Effect of Bacterial Starters on the Flavor and Chemistry of Provolone and Romano Cheeses

ARS-EU

Problem: To obtain specific information concerning the effects of different kinds of bacterial starters on the flavor and the biochemical changes in these cheese with the aim of selecting starters that would yield flavors equal to those in imported cheese.

Program: Contract with the Ohio Agr. Expt. Sta. Duration 4 years.

Progress: Results show that the flavor, quality and chemical composition of these cheeses are definitely affected by the composition of the bacterial starters and that certain specific chemical compounds seem to be related to the intensity of characteristic flavor. Starters containing Lactobacillus bulgaricus, Lactobacillus lactis and Streptococcus thermophilus gave much better results than those containing any one or two of these species. The presence of yeasts ruined flavor and texture. Free butyric acid, free glutamic acid, and the long chain neutral carbonyl compounds were related to intensity of flavor.

The ratio of surface area to depth of milk during the preparation of bacterial starters was found to greatly influence their production of acid during cheesemaking. The ratio for growing starters must be approximately the same as that in the cheese vat during cheesemaking.

These findings should immediately be of great practical value to makers of domestic Provolone and Romano cheese and should serve as a basis for future research on the chemistry of cheese flavors.

Plans: This research has been completed.

Publications

The Effect of Varying Ratios of Surface Area to Depth on the Acidity Development in Italian Cheese Starter Cultures. W. J. Harper and Rose M. Huber. Milk Products J. 48(8). 1957.

3. Starter Failures in Cheesemaking

ARS-EU

Problem: Intermittent failure of bacterial starters to form the required amount of acid during the making of Cheddar, Cheddar-like, and cottage cheese has resulted in serious economic loss to commercial cheesemakers.

Program: Contract with W. K. Moseley Laboratory, Indianapolis, Ind. Duration 5 years.

Progress: Results obtained with samples of bacterial starters, milk, and whey from starter failures in 88 commercial cheese factories in 16 States show that bacteriophage was present in almost every instance, whereas antibiotic-like substances were detected in only about one-fourth of the samples of milk. Bacteriophage was also present in 70% of the samples obtained from 22 factories not having starter failures.



Plans: A study of the specific conditions which permit an apparently normal activity of bacterial starters in the presence of bacteriophage, and the development of practical means for preventing starter failure.

#### Publications

Recent Research on Starter Failures: Progress Report. W. K. Moseley and R. L. Winslow. Proc. Res. Conf. on Cheese, Beltsville, Md., Oct. 1957.

New Developments in Composition and Propagation of Cheese Starters. R. P. Tittsler. Proc. 27th Ann. Insti. of Dairying, State College of Washington, Pullman, Was. March 1958.

Recent Developments and Trends in Cheese Research. R. P. Tittsler. Proc. 27th Ann. Insti. of Dairying, State College of Washington, Pullman, Wash. March 1958.

#### 4. Causes of Gassy Defects in Swiss Cheese

ARS-EU

Problem: The determination of the microbial flora of Swiss cheese in relation to factors affecting the development of gassy defects.

Program: Contract with the University of Wisconsin. Duration 4 years.

Progress: Results show that the gassy defect is caused by Clostridium tyrobutyricum, a gas- and butyric acid-forming, anaerobic bacillus that is commonly present in milk. Its growth and production of gas are favored by a lack of the usual amount of acid formed by starter bacteria and stimulated by associative growth of certain other bacteria that are usually present in Swiss cheese. The development of gassy cheeses was not related to feeding cows grass silage. The main contributing factors were found to be inactive lactic-acid-forming starters, poor quality milk and improper cheesemaking procedures. The most practical means for preventing gassy defects in Swiss cheese seem to be the use of good quality milk and active acid-forming starters.

Plans: This research has been completed.

#### Publications

Effect of Temperature on Acid Production by *Streptococcus lactis* and *Streptococcus cremoris*. J. W. Wold and R. P. Tittsler. Abstract. J. Dairy Sci. 41(5). 1958.

Interrelationships Between pH, Populations of *Propionibacterium shermanii*, Levels of Free Fatty Acids, and the Flavor Ratings of Swiss Cheese. F. E. Kurtz, J. A. Hupfer, E. A. Corbin, R. E. Hargrove, and H. E. Walter. Abstract. J. Dairy Sci. 41(5). 1958.



5. New Methods For Pasteurizing and Deodorizing Milk

ARS-EU

Problem: To design new types of equipment and to develop improved methods for pasteurizing, deodorizing, and/or condensing milk for use in the manufacture of cheese.

Program: A continuing program of equipment design research on a pilot plant scale to increase the efficiency and economy of producing cheese and increasing plant production without increase of equipment carried on in the Washington Lab., involving 2 professional Federal man-years annually.

Progress: A new type of equipment for pasteurizing, deodorizing, and slightly condensing milk has been designed and is being tested experimentally on a pilot-plant scale to improve methods for processing milk. With this equipment the milk is first pasteurized by steam injection (162° F.) using conventional holding time (15 seconds) and then treated in a vacuum chamber where the condensed steam and volatile flavors are removed, whereas with present commercial equipment the milk is pasteurized before it is treated with steam and vacuum or is heated much higher (195° F.) with no holding time and then vacuum treated. Cheese has been made from treated milk. An application has been filed for a public service patent.

Plans: Studies will be made to determine the effects of variations in the temperature and vacuum treatment of milk on the quality of cheese, and to establish optimum time-temperature relationships and vacuum treatment for operating such equipment in cheese factories.

6. Fluorescent Dyes as Markers for Detecting Antibiotics in Milk

ARS-EU

Problem: Development of a rapid indicator test for the detection of antibiotics in milk that cause starter failures in cheese making.

Program: A continuing research project, carried on in the Washington Lab., in cooperation with AH and Food and Drug Admin., and involving less than 1 professional Federal man-year annually in EU.

Progress: The milk from cows treated for mastitis by udder infusion of antibiotics contains sufficient antibiotics for several days after treatment to inhibit bacterial starters used in making cheese and fermented milks, and many dairy manufacturers have suffered serious economical loss because of starter failures. The presence of penicillin in milk presents a serious health problem because some persons are allergic to it.

Although sensitive and reliable tests for antibiotics in milk are available, all of them are laboratory tests that require special equipment, from 2½ to 8 hours, and skilled technicians. Such tests are not suitable for practical use by cheesemakers and dairy farmers. The feasibility of adding fluorescent dyes to veterinary antibiotics as a practical, rapid, and indirect means of detecting antibiotics in milk has been investigated.



Results show that the addition of a combination of 125 mg. of oil-soluble fluorescein and 125 mg. of uranine per dose of antibiotic as a marker serves as a satisfactory means for rapidly detecting antibiotics in milk. Fluorescent dyes did not alter the antibiotic activity of penicillin during storage; could be detected visually in the milk from treated cows for 48 hours following their treatment and with ultraviolet light for 96 hours; were excreted for practically the same period as the antibiotics in 8 different commercial veterinary preparations; did not affect milk production; and were not toxic or irritating to the treated animals.

Plans: The results are being summarized for publication and long-time storage tests for stability of antibiotics in the presence of the fluorescein-uranine mixture are being continued. Investigation of alternative fluorescent materials such as chlorophyll will be carried out.

#### Publications

The Use of Fluorescent Materials for the Indirect Detection of Antibiotics in Milk. R. E. Hargrove, R. J. Lehman, and C. A. Matthews. J. Dairy Sci. 41(5). 1958.

### B. CONCENTRATED AND DRIED MILKS

#### 1. Foam Drying of Whole Milk

ARS-EU

Problem: To develop a commercially feasible process for making dry whole milk having good dispersibility, fresh milk flavor, and stability on storage, thereby making available to the housewife a supplemental supply of milk and expanding overall milk consumption.

Program: A long range program involving chemical engineering research on process development and basic studies of the factors responsible for dispersibility and flavor stability carried out at Philadelphia and Washington Labs., and involving about 23 professional Federal man-years annually.

Progress: Engineering Studies - During the year emphasis was placed on studies of the effect of processing variables and packaging conditions on the flavor shelf life of foam dried whole milk and on the installation of the continuous vacuum dehydrator as part of an integrated pilot plant.

It was demonstrated that reconstituted freshly prepared foam dried whole milk is about equal in flavor and texture to fresh fluid milk. A preference poll at the Philadelphia Lab. involving 209 people showed that 48% either preferred the reconstituted dry whole milk or had no preference. Of the 110 people who preferred the fresh fluid milk, 48 indicated that they would buy the dry milk if they could do so at a favorable price differential (about 5 cents per quart). Storage tests on flash pasteurized whole milk, foam dried by the batch process, show



that the final moisture content has a profound influence on flavor shelf life. Moistures significantly above the maximum of 2.25% allowed by the U. S. Standards are beneficial. The excellent initial flavor is retained for only one to two weeks at room temperature storage when the moisture is between about 1.0 and 2.25%. With moisture contents of 3 and 3.25% there was no significant difference between the stored product and freshly dried whole milk after 9 to 12 weeks storage at room temperature. The samples are evaluated by employing a large, screened taste panel and by statistical procedures designed to show small differences in flavor.

The efficacy of higher final moisture contents was confirmed by studies on the use of inpackage desiccation (IPD). Lowering of the moisture with IPD during storage increased the rate of flavor deterioration in every case studied within the moisture range of about 1.0 and 3.25% when packaged. Tests are under way to determine the range of product moisture contents required for optimum storage.

Attempts to increase the shelf life of foam dried milk by forewarming under various conditions to develop natural antioxidants impaired both the flavor and dispersibility of the product. Conditions were 2, 5 and 8 minutes at 195° F. and 30 minutes at 165° F. A consumer panel of 227 untrained tasters showed a statistically significant preference for the fresh (unheated) foam dried product over that prepared from milk heated at 165° F. for 30 minutes. Comparisons of stored samples have not yet been made.

Since the installation of the continuous vacuum dehydrator, some 50 test runs have been made. These indicated the need for a number of minor mechanical modifications. There are a large number of inter-related operating factors which must be studied to determine the best conditions. Although much must yet be done to arrive at a commercially feasible continuous process, results indicate that such a goal may be attainable.

Plans: Work will include further studies on the effect of process variables and packaging conditions on flavor retention and the development of flavored dry whole milks.

Chemical Studies - Further improvements in stability of foam dried whole milk powder during storage are highly desirable. Completed work on "free" fat (that portion of the fat which is readily extracted by non-polar organic solvents such as carbon tetrachloride) showed that free fat is affected by the form and extent of lactose crystallization. Relatively wide variation in free fat, surprisingly, causes little change in dispersibility.

Packaging the powder at 0.1, 1.0 and higher concentrations of oxygen showed that stability toward oxidative deterioration is inversely proportional to the oxygen concentration, a fact already established for whole milk powder prepared in other ways.



The heat treatment which milk received during processing has a definite effect on the flavor stability of its products. Minimal heat treatment (145° F. for 30 minutes) yields inadequate stability; excessively high heat (185° F. for 30 minutes) results in an objectionable cooked flavor. An intermediate treatment (165° for 30 minutes) was selected as a compromise to give a product with very little cooked flavor that is stable for several months at the lower oxygen concentrations at 80° F. This temperature was chosen to give an accelerated rate of change. Preliminary experiments with antioxidants indicate that some protect milk powder from oxidative deterioration for a significant time. Of those tested, propyl and lauryl gallate were best.

The phospholipids or phosphatides are complex fatty materials containing combined phosphoric acid and organic bases in addition to the fatty acids and glycerine. They occur in milk on the surface of the fat globule, and much recent evidence has accumulated to show that they are important in the development of oxidative off-flavors. Experimental results show that the agitation of milk in normal processing steps causes a migration of the phospholipids from the fat globule to the milk serum. Recent work indicates that homogenizing under high pressures causes a reversal of this migration.

As a fundamental consideration of the possible implication of enzymatically catalyzed flavor changes in stored "foam dried" whole milk, a study of the fat-splitting enzymes of milk has been undertaken. Investigation has revealed the presence of a lipoprotein lipase in the cream fraction of milk. At least a 50-fold purification has been attained.

Plans: Further tests will be made with antioxidants to determine the optimum conditions of use. Flavor stability and dispersibility in foam and spray dried milks will be compared. The mechanism of the drying process will be studied and attempts made to apply the results to the preparation of a better milk powder. The intensive study of flavor in dry milk, particularly the isolation and identification of compounds concerned especially with oxidative flavor, will be expanded. A consumer taste panel study of what flavors are preferred in milk is planned, to be done by contract. Further studies on the effects of homogenization on the distribution of the phospholipids in milk will be pursued with the goal that this can be so controlled that an improved milk powder can be made. The study of the milk lipase system will be continued and extended to the other enzyme systems in milk.

#### Publications

Dry Whole Milk. I. A New Physical Form. H. I. Sinnamon, N. C. Aceto, R. K. Eskew, and E. F. Schoppet. Jr. Dairy Sci. 40(9). 1957.

Dispersibility of Foam-Dried Fat-Containing Milk Products. R. K. Eskew, N. C. Aceto, H. I. Sinnamon and E. F. Schoppet. J. Dairy Sci. 41(6). 1958.



Publications (continued)

The Distribution Between the Fat Phase and the Aqueous Phase of Certain Antioxidants Added to Whole Milk. J. Martinez-Mateo, W. L. Choate, and L. F. Edmondson. Abstract. J. Dairy Sci. 41(5). 1958.

Free Fat in Foam Dried Whole Milk. A. Tamsma, L. F. Edmondson and H. E. Vettel. Abstract. J. Dairy Sci. 41(5). 1958,

The Migration of Phosphatides in the Processing of Dairy Products. I. Foam and Spray Dried Whole Milk. G. R. Greenbank. Abstract. J. Dairy Sci. 41(5). 1958.

Use of T-Butyl Hypochlorite for Detection of Nitrogenous Compounds on Papergrams. D. P. Schwartz and M. J. Pallansch. Analytical Chem. 30(2). 1958.

Detection of Tyrosine on Paper Chromatograms. D. P. Schwartz and M. J. Pallansch. Analytical Chem. 29(10) 1957.

2. Preparation of Improved Evaporated Milk

ARS-EU

Problem: To develop sterile concentrated milks with the flavor of fresh milk, that are chemically and physically stable, and which will retain as nearly as possible its flavor during storage.

Program: A continuing program of applied research for the development of new methods in evaporated milk processing, carried on at Washington, involving 1.5 professional Federal man-years annually.

Progress: Studies have continued on the sterilization of concentrated milks by a continuous high-temperature short-time (HTST) process (278° F. for 15 seconds) as a means of minimizing cooked flavor. Installation of a new homogenizer in the processing arrangement has been made so that aseptic homogenization at pressures up to 8,000 p.s.i. can be accomplished. This sequence minimizes fat separation in the stored product. Viscosity determinations made just before and after homogenization of the sterile product indicate that a reproducible optimum initial "grain point" or viscosity may be obtained. These results are being correlated with changes in viscosity, gelation and protein sedimentation during storage. Preheating of the concentrate at 180° F. for 30 minutes markedly increased the cooked flavor of the HTST product. Other workers have found this treatment to be beneficial for retarding gelation of the stored product.

A new microviscometer has been designed and proven to give results completely in accord with larger scale instruments. By its use the stabilizing effect of additives on the storage stability of concentrated milk can be studied. In addition the effects of continuous multipass homogenization have been studied theoretically and experimentally as a means of achieving a high degree of homogenization of small samples at low pressure. These two new methods are extremely valuable in research on concentrated milk.



Studies of the binding of riboflavin and riboflavin phosphate to milk proteins have been completed. The results show that the binding is upon the tyrosine residues of the protein and that binding takes place through hydrogen bonding. It also was demonstrated that riboflavin is stabilized against the destructive effects of light by this binding to the protein.

Plans: A thorough study of aseptic homogenization of this product so that reproducible conditions for minimizing gelation and fat separation can be determined, including variations in heat treatments, homogenization pressures and temperatures and degree of concentration at the time of homogenizing. Flavor studies will be carried out along with the variations in processing conditions. Basic studies of the changes in proteins during processing and storage, will be undertaken.

#### Publications

The Effect of Heat on the Centrifugal Sedimentation of Milk Serum Proteins. L. F. Edmondson. J. Dairy Sci. 41(4). 1958.

Separation of a Calcium-Soluble Fraction of Casein from Isoelectric Casein. K. K. Fox. Abstract. J. Dairy Sci. 41(5). 1958.

Use of Sucrose in the Preservation of Frozen Condensed Skimmilk. R. W. Bell. Milk Products J. 48 (9). 1957.

Factors that Affect the Stability of Frozen Concentrated Milk. R. W. Bell. Milk Products J. 48 (8). 1957.

The Binding of Calcium Ions by Beta-Lactoglobulin Both Before and After Aggregation by Heating in Presence of Calcium Ions. C. A. Zittle, E. S. Della Monica, R. D. Rudd and J. H. Custer. J. Amer. Chem. Soc. 79. 1957

Effect of Calcium Chloride and Heat on Solutions of Mixtures of Beta-Lactoglobulin and Casein. E. S. Della Monica, J. H. Custer and C. A. Zittle. J. Dairy Sci. 41. 1958.

### 3. Compositional and Stability Variations of Milk Related to Season and Breed

ARS-EU

Problem: To determine the shifts in salt equilibria and instability of the caseinate particles produced in milk by various heat treatments for the purpose of increasing utilization of milk in the preparation of such milk products as evaporated and dry milk.

Program: Contract with the University of Minnesota. Duration 5 years.

Progress: To establish a rational basis for the control of changes that occur in milk during heating, the study of the compositional and stability variations that occur in milks drawn from various breeds of cows at different stages of lactation has been continued. Significant



variations in composition and heat stability of milk drawn from individual cows has been noted.

A further study of the effect of the addition and removal of calcium on the salt equilibrium and heat stability of milk has been made. The relationships between the calcium, phosphates, and citrates in milk have been worked out. No good correlation has yet been established between the calcium content of milk and its heat stability. A study of the effects of heat treatments of the type commonly used in the production of milk concentrates on the salt equilibria in milk has been initiated.

Plans: This work, along with the compositional studies of milk drawn from individual cows, will be continued and completed during the coming year.

#### 4. High Milk Protein Bread

ARS-EU

Problem: To increase the consumption of milk in baked products.

Program: A continuing program of applied research for the utilization of milk products by the baking industry, carried on in the Washington Lab. and involving 1.5 professional Federal man-years annually.

Progress: An excellent, high milk protein bread has been developed, containing 25 parts of NFDM per 100 parts of flour. Dough preparation and baking schedules are relatively simple and could be easily adapted to commercial bakeries. The bread has an excellent flavor and texture. It has good loaf volume and resists staling well. It has a dark, but not objectionable, crust color. Experimental bread has had good consumer acceptance. In cooperative research with the Food and Drug Admin., it has been found that the biological value of the protein in such bread is almost twice that in bread containing only 4 parts of NFDM. This high protein bread, which closely resembles ordinary high-quality, white pan bread, may well have a ready sale in today's diet-conscious market.

Plans: Additional studies on the nutritional value, resistance to staling, and other properties and characteristics of bread made under varied conditions. Consumer acceptance of experimentally made bread will be determined on a greater scale. If the results continue to be satisfactory, market tests in cooperation with AMS and retail manufacturers will be sought.

#### Publications

High Milk-Protein Bread. L. V. Rogers and Helen H. Welton. Abstract. J. Dairy Sci. 41(5). 1958.

Effect of Superheating on the Baking Properties of Nonfat Dry Milk. L. F. Rogers, H. A. Anderson, and C. F. Hufnagel. Abstract. J. Dairy Sci. 41(5). 1958.



4. The Control of Bacterial Spores in Milk

ARS-EU

Problem: To study the effects of physical or chemical agents upon the germination and control of bacterial spores; to determine the physical and chemical properties of the constituents of bacterial spores, and to use this information in modifying the properties of spores to obviate the need of high treatment in the preservation of milk.

Program: A continuing basic research project designed to answer a preplexing problem in the preservation of milk, carried on in the Washington Lab., involving 3 professional Federal man-years annually.

Progress: The recently developed Centri-Filmer Process has been used successfully for the ultraviolet sterilization of blood plasma and vaccines, and is being used as a potential means of sterilizing milk. Findings may be summarized as follows: Radiation conditions necessary to kill most of the inoculated spores imparted an objectionable light-activated flavor and odor to the milk, which was greater in skim than in whole milk. Limited efforts to prevent off-flavor during irradiation, or to eliminate it after development, were not successfully. The process did not effect a complete kill of inoculated spores. Pre-radiation heating sufficient to inactivate most of the lipase in the milk intensified the off-flavor that developed during radiation. From these and other considerations it is concluded that ultraviolet radiation (Centri-Filmer Process) is not a practicable means of sterilizing milk.

A chief obstacle to the elimination of high temperature heating in the processing of milk is the phenomenon of delayed germination or dormancy exhibited by an extremely small fraction of the spore population. Studies directed to this problem have revealed that certain chelating agents such as Di Sodium Calcium Versenate or Versenol in suitable concentrations materially increased the germination of dormant spores in milk; it was also observed that dormant spores were more inhibited by lower concentrations of these agents than were non-dormant spores. Thus a relationship is indicated between dormancy and the concentration level of certain metallic ions in milk, with evidence that the greater sensitivity of dormant spores is not limited to metallic ions.

Gibberellins, reported to hasten the germination of plant seeds and to overcome dormancy have been found to have negligible effect upon spore germination.

A unique and abundant component of apparently all spores is dipicolinic acid (DPA). Although the function of this compound is unknown, there is reason to believe that it is concerned in some way with resistance and may play a role in spore germination. Since the form or combination in which DPA exists in the spore is also unknown, efforts have been made to prepare antibodies against DPA conjugates for possible use in precipitating SPA-containing complexes in spore



extracts. This work has been carried out in cooperation with the Univ. of California. Efforts to produce antiserum against purified DPA were unsuccessful. Products believed to be conjugates of beta-lactoglobulin (BLG) and of bovine serum albumin (BSA) with DPA were prepared. Although antibodies were produced in rabbits against both BLG and BSA, each complex elicited antibodies only against the protein.

Plans: The studies on chelating agents and DPA will be continued. Since the immunological response of rabbits may vary with physiological condition and age of the animal, further tests will be made with these and possibly other DPA conjugates.

A systematic chemical study of soluble and insoluble spore fractions is contemplated.

### Publications

The Mineral Requirements for Sporulation. H. R. Curran. Spores, Amer. Inst. of Biological Sci., Washington, D. C.

## 5. Effect of High-Energy Radiation on Spore Germination

ARS-EU

Problem: To study the effects of high energy radiation upon the germination and biochemical response of bacterial spores as a potential means of lowering the temperature necessary to sterilize milk.

Program: Contract with the University of Illinois. Duration 2.5 years.

Progress: An attack on the problem of bacterial spores dormance and its relations to heat processing is being carried out. This involves a study of the effects of high energy (gamma) radiation upon the spore germination. It became necessary to refine the quantitative aspects of the experiments in order to obtain the desired information and improve its accuracy. Results reveal that up to 10,000 rads of irradiation had no detectable effect upon dormancy of the spores; levels above  $1 \times 10^6$  rads caused the spores to become nonviable; in contrast, irradiation between 10,000 and  $1 \times 10^6$  rads significantly decreased spore dormancy, which manifested itself in greatly decreased resistance to heat; at the latter dosage levels, the treatment had no measurable effect upon the viability of spores. It is noteworthy that this effect was achieved in non-nutrient media.

Plans: This study will be extended to another organism, after which the irradiation substrate will be analyzed biochemically in the hope that clues will be provided concerning the mechanism of spore germination and of heat resistance.

## C. BUTTER AND BUTTERFAT

### 1. Concentrated Sweetened Cream

ARS-EU

Problem: The development of new outlets for butterfat and the preservation of milk fat in the form of a sweetened cream product.



Program: A continuing program of applied product research carried on in the Washington Lab., involving less than 1 professional Federal man-year annually.

Progress: A new concentrated butterfat product has been developed. It is concentrated sweetened cream, made by (a) preparing a concentrated cream, (b) adding nonfat dry milk to stabilize the fat, (c) adding sugar to preserve the product, and (d) pasteurizing the mixture. It can be homogenized to increase stability of the fat emulsion, suppress lactose crystallization, and improve whipping properties. A typical formula contains approximately 40% butterfat, 8% nonfat milk solids, 32% sugar, and 20% water. It resembles sweetened condensed milk in appearance, flavor, and consistency. The product can be stored satisfactorily at 50-60° F., thus affording a distinct economic advantage over the storage of butterfat in a frozen state. Potential uses are in ice cream, bakery products, candy, and as a topping. When properly diluted, it can be whipped like a mixture of fresh cream and sugar.

Two applications for public service patents have been filed.

Plans: Future work will involve studies on the effects of variations in the formula and in storage conditions on quality and stability, on packaging, and of additional uses for the product. If apparent merits of the product are confirmed, commercial-scale tests in cooperation with industry will be desirable.

#### Publications

A New Dairy Product for Ice Cream -- Concentrated Sweetened Cream. Arjen Tamsma and R. W. Bell. Proc. International Assoc. of Ice Cream Manufacturers, San Francisco, Calif., Oct. 1957.

## 2. Unsaturated Acids of Butterfat

ARS-EU

Problem: To develop basic information regarding the minor components of butterfat in order to increase knowledge regarding their effect on stability of butter and nutritional significance.

Program: A continuing program of basic research carried on in the Philadelphia Lab., involving about 1 professional Federal man-year annually.

Progress: The unsaturated acids of butterfat are of interest because their oxidation with atmospheric oxygen causes a type of rancidity and off-flavor in dairy products, and also because certain growth promoting properties and nutritional significance have been attributed to them. Examination of the fatty acids of butterfat has shown that very highly unsaturated fatty acids, containing 5 double bonds, with chain length of 20 and 22 carbon atoms, are present in about 0.2% concentration in the butterfat. The relationship between the presence of these compounds and the susceptibility of butterfat to oxidation has not been worked out.

Plans: Work will be directed toward isolation of the still-unknown components of butterfat.



3. Interesterification of Butteroil

ARS-EU

Problem: Chemical modification of butteroil by interesterification to obtain a product with properties more suitable than those of normal butteroil for use in baked goods.

Program: A study carried on the Washington Lab., involving less than 1 professional Federal man-year annually.

Progress: The random interesterification of butteroil, accomplished with a catalyst at temperatures of 50 to 85° C., gave a product with increased plastic range as determined by hardness and volumetric measurements. Directed interesterification, accomplished at temperatures below 50° C., gave a product with a much greater plastic range than the random procedure. Both products sometimes possessed minor flavor defects that have not been uniformly prevented or controlled. Tests based on changes in solubility of the glycerides in 95% alcohol were developed as one measure of the extent of interesterification.

Plans: A completed project.

Publications

Properties of Interesterified Butteroil. H. D. Weihe and G. R. Greenbank. Abstract. J. Dairy Sci. 41(5). 1958.

4. Spreadability of Butter

ARS-EU

Problem: To improve the spreading qualities and characteristics of butter to provide a more acceptable product to the consumer and thereby maintain the competitive position of butter.

Program: Contract with the Ohio Agr. Expt. Sta. Duration 4 years.

Progress: Research on the physical properties of butter, development of better spreadability, and the effect of processing and storage conditions on spreadability has made excellent progress. Efforts to improve the spreadability characteristics of butter include the addition of edible substances which may influence this physical characteristic. A mechanical means of measuring spreadability has been correlated with consumer values on an extensive series of butter samples. The use of this objective mechanical method will greatly increase the number of samples which can be tested.

Plans: A survey is being made of the spreadability of butter samples from 75 manufacturing plants distributed over the U. S. The effect of additives will be studied more intensively.



5. Oxidized Flavor in Butter

ARS-EU

Problem: Improving the stability of butter flavor, with special reference to control of oxidative phenomena.

Program: Contract with Iowa State College. Duration 3.5 years.

Progress: Flavor stability, particularly the prevention of oxidative deterioration, is a pressing problem of the butter industry. Studies are under way of the chemical reactions which take place as butter develops oxidative defects as judged by taste testing. A search is being made for practical ways to prevent these changes and for a test to determine the shelf life of butter with respect to oxidative deterioration. The first stages of the work were devoted to the development of analytical methods for the isolation, separation and identification of those organic compounds which are believed to be responsible for oxidized flavor defects in butter. The aldehyde or ketone structure is characteristic of these substances and has been used as a basis for their measurement. Preliminary results of chemical analysis and taste tests indicate that 1, or at most a few carbonyl compounds, is responsible for the characteristic oxidized flavor of butter.

Plans: More complete identification of the volatile oxidized flavor components will be pursued. Reproduction of the flavor in naturally oxidized butter will be tested by adding the isolated flavor components to fresh butter. A comparison of the oxidized flavor which develops at low temperature storage will be made with that which develops at the higher temperatures used in the experiments.

Publications

Antioxidants in Food. G. R. Greenbank. Encyclopedia of Chemistry. Reinhold Publishing Corp., New York.

A Comparison of Detergent Tests for Butterfat in Milk with Official Methods. S. R. Hoover, T. J. Mucha, and W. R. Harvey. J. Dairy Sci. 41(3). 1958.

D. MILK CONSTITUENTS

1. Separation and Characterization of Pure Milk Proteins

ARS-EU

Problem: Development of new outlets for milk through basic studies on the composition and nature of milk proteins.

Program: A continuing program of basic research that will be a portion of the program of the newly formed pioneering laboratory, carried on at Philadelphia, involving 2 professional Federal man-years annually.

Progress: A re-investigation of alpha-casein, the principal electrophoretic component of casein, has led to the separation of at least five proteins from this casein fraction, differing in phosphorus content



and other chemical and physical properties. One of the separated components, designated  $\alpha_1$ -casein, constitutes 80% of the total alpha-casein fraction and is easily precipitated from solution by calcium salts. The other four components are soluble in an excess of calcium salts and have a stabilizing effect on  $\alpha_1$ -casein as well as beta-casein in the presence of calcium salts. Each of the minor components of alpha-casein is clotted by the enzyme rennin. These studies are of fundamental importance with respect to the stability of casein in milk and the action of rennin on milk and may lead to better methods of stabilizing milk products.

The investigation concerned with the location of the phosphorus in casein has been continued. Casein, as well as its electrophoretic components, was partially hydrolyzed with pepsin. The phosphopeptides produced were found to vary in size and composition. These purified fragments of the casein molecule will be valuable in determining the sequence of amino acids in casein. It was found by means of studies of the splitting of phosphorus from casein with phosphatase enzymes, that all of the phosphorus is linked with casein in one type of linkage, probably monoester of orthophosphoric acid. This is contrary to the prevailing view which is widely accepted.

Plans: Transfer program to new pioneering laboratory.

#### Publications

The Separation and Amino Acid Composition of a Pure Phosphopeptide Prepared from Beta-Casein by the Action of Trypsin. R. F. Peterson, L. W. Nauman and T. L. McMeekin. J. Amer. Chem. Soc. 80. 1958.

The Phosphopeptides Obtained from Alpha-, Beta-, and Whole Casein by Partial Hydrolysis with Pepsin. M. L. Groves, N. J. Hipp, and T. L. McMeekin. J. Amer. Chem. Soc. 80. 1958.

## 2. Structure of Milk Proteins

ARS-EU

Problem: To determine the factors affecting the stability of milk proteins in heat processed milk products through studies on modified milk proteins using proteolytic enzymes.

Program: A continuing program of basic research, carried on at Philadelphia and involving 2 professional Federal man-years annually.

Progress: A beginning has been made on the determination of the amino acid sequence of alpha-lactalbumin. This protein was selected because it is relatively small in size, having a molecular weight of 15,000. Alpha-lactalbumin as well as its acetylated and guanidinated derivatives were hydrolyzed by means of trypsin. It was found that the number of peptides produced from the modified alpha-lactalbumin was greatly reduced, which is of considerable practical advantage for structural studies. Difficulties have been encountered in the separation of the fragments of alpha-lactalbumin produced by trypsin. In



the course of this investigation, it was found that protaminase, a previously unpurified enzyme from the pancreas gland, was of particular value in determining the position of arginine and lysine in peptides produced by the action of trypsin on alpha-lactalbumin.

Plans: Program will be continued at its present level.

Publications:

Studies on the Proteolytic Enzyme System of the Pancreas. L. Weil and M. Telka. Arch. Biochem. and Biophysics, 71, 1957.

Tryptic Digestion of Native and Chemically Modified Alphas-lactalbumin. L. Weil and M. Telka. Arch. Biochem. and Biophysics, 71, 1957.

3. Factors Affecting the Stability of Milk Proteins

ARS-EU

Problem: To determine the factors affecting the stability of evaporated milk, and in particular the calcium and phosphate ion combining capacity of ratios and heated milk proteins.

Program: A continuing program of basic research designed to improve the quality of evaporated milk through studies of the mechanism involved in the stability of evaporated milk during heat sterilization, carried on at Philadelphia, and involving 2 professional Federal man-years annually.

Progress: Studies of factors affecting the precipitation of milk proteins in milk concentrates have been continued. It was found that casein precipitated by calcium chloride and heat dissolved at room temperature in the presence of sodium chloride and citrate, but not in the presence of phosphate. In the presence of excess phosphate, the precipitation of casein by calcium chloride and heat was prevented.

It has been reported that when a mixture of casein and beta-lactoglobulin is heated in the presence of calcium chloride a complex of the two proteins is formed. Studies of such mixtures involving ultracentrifugation, electrophoresis and chemical analysis showed that under these conditions, no stable complex between the two proteins is formed. It was found that the binding of calcium ions by beta-lactoglobulin is unaffected by aggregation by heating in the presence of calcium ions. The electrophoretic mobility of beta-lactoglobulin is decreased by the presence of calcium ions due to an increase in the isoelectric point of the protein.

The nature of the soluble nitrogen produced when casein was clotted with rennet was determined. It was found that the soluble nitrogen amounted to 2 to 5% of the protein and that it contained a number of components of a fairly large size.



These detailed studies are developing a fundamental insight into the changes taking place during the processing of milk.

Plans: Studies will be continued along the same lines.

Publications:

Electrophoresis of Beta-lactoglobulin in the Presence of Calcium Chloride. C. A. Zittle and J. H. Custer. Arch. Biochem. and Biophysics, 71, 1957.

Clotting of Casein with Pepsin: Amount and Nature of the Soluble Products. C. A. Zittle and J. Cerbulis. J. Dairy Sci., 41, 1958.

4. Physical-Chemical Studies on Milk Proteins

ARS-EU

Problem: The determination of the molecular weight of milk proteins and factors affecting their association.

Program: A research project carried on at Philadelphia, in cooperation with AH, and involving 2 professional Federal man-years annually.

Progress: Physical-chemical studies on the state of aggregation of beta-lactoglobulin were continued. Ultracentrifugal, electrophoretic and light-scattering measurements were carried out on a number of samples of this protein with the conclusion that between pH 3.5 and 5.2, part of beta-lactoglobulin aggregates to a tetramer at cold temperatures. Examination of protein samples obtained from the milk of individual cows revealed that one genetic species of beta-lactoglobulin (beta-lactoglobulin A) is responsible for the association, while beta-lactoglobulin B does not aggregate by itself. Examination of the two genetically different proteins showed that both dissociate into half molecules (mol. wt. 17,500) at acid pH, the dissociation being most pronounced below pH 2.5.

A screening program of the proteins of milk obtained from individual cows was initiated. The screening is carried out by paper electrophoretic examination of the whey proteins for genetic differences. Of 62 cows examined, 10 were found to be of genetic type A/A, 21 of type B/B, and 31 of type A/B according to their beta-lactoglobulin. No difference in alpha-lactalbumin type was detected.

Plans: The study has been completed but only in a preliminary manner. Further work along related lines will be carried out under a new project.

Publications:

The Molecular Weight of Beta-lactoglobulin. R. Townend and S. N. Timasheff. J. Amer. Chem. Soc., 79, 1957.



The Molecular Weight of Ribonucleic Acid Prepared from Ascites-tumor Cells. S. N. Timasheff, R. A. Brown, J. S. Colder, and M. Davies. Biochem. Biophys. Acta. 27, 1958.

The State of Plasma Albumin in Acid pH. S. N. Timasheff and R. J. Gibbs. Arch. Biochem. and Biophysics, 70, 1957.

5. Studies of Caseinate Complex in Milk

ARS-EU

Problem: The determination of the size, shape and related properties of the casein complex as it exists in milk and the effects of processing conditions upon these properties.

Program: A continuing investigation of factors affecting the instability of concentrated milk during processing and storage carried on in Washington Lab. involving 3 professional Federal man-years annually.

Progress: The isolation of kappa-casein from milk was first announced in 1956. Its reported effects on the properties of some heated milk products are of great interest. For further studies of these effects supplies of the pure protein are needed. Kappa-casein was isolated and the product behaved as a single substance in electro-phoresis and ultracentrifugation. It had properties identical with those of  $\alpha_2$ -casein.

Progress was made in the study of the caseinate complex as it exists in milk. It was shown that the particles of widely different size ranges contain the same relative proportions of alpha-, beta- and gamma-casein. It was further shown that these small particles, when dialyzed against milk reaggregated to large aggregates. The size of these aggregates was proportional to that of the original sizes of the caseinate complex. This phenomenon was called "size memory." In other related studies the existence of caseinate complex particles of definite sizes in milk, was confirmed and extended.

Plans: These studies are temporarily in abeyance but will be resumed as soon as it is feasible.

Publications: Magnesium in the Casein-containing Colloid in Milk. T. G. Alexander and T. F. Ford. J. Dairy Sci., 40, (10) 1957.

A Nitrogen Factor for the Calcium Caseinate-calcium Phosphate Complex in Milk. T. F. Ford, G. A. Ramsdell, Shirley G. Landsman, and T. G. Alexander. J. Dairy Sci., 40, (11) 1957.

Size Memory of Casein Colloid Particles. W. L. Choate, F. A. Heckman, T. F. Ford. Abstract. J. Dairy Sci., 41 (5), 1958.



Electrophoretic and Ultracentrifugal Analysis of Casein Complex Size Fractions from Milk. F. A. Heckman, W. L. Choate and T. F. Ford. Abstract. J. Dairy Sci., 41, (5) 1958.

Optical Ultracentrifugal Resolution of Casein Complex particles in Milk. T. F. Ford, Lorraine W. Klipp, G. A. Ramsdell, and W. L. Choate. Abstract. J. Dairy Sci., 41, (5) 1958.

6. Identification and Characterization of Allergens of Cows' Milk ARS-EU

Problem: Awareness of allergy to cows' milk has acquired increasing significance in consequence of the growing trend toward replacement of breast milk with cows' milk, variously modified, as the principal food for newborn infants.

Program: A continuing basic research program carried on by the pioneering laboratory, Allergens in Agricultural Products.

Progress: Investigations on cows' milk were begun to identify and characterize the allergenic components with respect to their comparative importance in sensitizing capacity, their chemical nature and to establish the susceptibility of these allergens to inactivation by the currently used processing practices. The following observations were derived from preliminary results. The sensitizing capacity of skim milk was not significantly altered by pasteurization. In comparison with raw milk, the commercial processes employed in making evaporated milk and spray-dried skim milk resulted in a 15-fold reduction in the sensitizing capacity of these products. Neither pasteurization nor spray-drying had a notable effect on capacity to induce the anaphylactic reaction in specifically sensitized guinea pigs. This capacity was substantially diminished in a comparable sample of evaporated milk.

Plans: Investigations of antigenic properties of processed milk products will be expanded to include the immunologic study of individual milk-protein fractions in order to determine their relative importance as potential allergens.

E. WHEY UTILIZATION AND WASTE DISPOSAL

1. Waste Disposal

ARS-EU

Problem: To develop economical and efficient methods of treating whey from cheese by means of aeration studies, in order to alleviate the waste disposal problem and reduce stream pollution caused by cheese plants.

Program: A continuing program of applied research which will benefit the cheese industry and the public as a whole, carried on at Philadelphia, involving 2 professional Federal man-years annually.



Progress: Waste water containing large amounts of whey from cheese factories may be readily treated by the aeration method previously devised if sufficient oxygen (air) is provided to satisfy the biological activity of the sludge. Added nitrogen may accelerate the oxidation of the sludge, but does not influence purification or removal of the solubles from the waste water. Purification is rapid. Under certain conditions 90% of the organic oxygen demanding materials are removed in 30 minutes. After the supernatant liquid is drawn off, the sludge is aerated to oxidized stored material. Prolonged treatment of whey under laboratory conditions caused a deterioration of the oxidizing ability of the sludge, but did not have an adverse effect on whey removal or purification. It is believed that under plant conditions, sufficient supplements may be added from other wastes to avoid this impairment in oxidation.

Exploratory studies in which radioactive tagged glucose was added to dairy waste sludge showed that each carbon of the sugar is probably used differently by micro-organisms. In a short aeration period (5 hrs.), 42% of C-1 is found as  $\text{CO}_2$  while only 5% of C-6 is thus used for energy. More C-6 is found in the cell than C-1, although a much greater amount is unused, 40% as compared to 22%. A continuation of this study may lead to information as to substances elaborated by the sludge and left by the aeration process.

Plans: This work is nearly completed. Consultation with and assistance to industry in utilizing these results will be continued.

Publications:

Microbiological Process Report. Activity of Micro-organisms in Organic Waste Disposal. I. Introduction. N. Porges. Applied Microbiol. 5, 1957.

Microbiological Process Report. Activity of Microorganisms in Organic Waste Disposal. IV. Bio-calculations. W. W. Eckenfelder, Jr., and N. Porges. Applied Microbiol., 5, 1957.

Application of Biochemical Studies to Dairy Waste Treatment. N. Porges and L. Jasewicz. 8th Ann. Proc. Pacific Northwest Indust. Waste Conf. Washington State College, 51 1957.

Practical Application of Laboratory Data to Dairy Waste Treatment. N. Porges. Food Tech., 12, 1958.

Aeration of Whey Wastes. I. Nitrogen Supplementation and Sludge Oxidation. L. Jasewicz and N. Porges. Sewage and Industrial Wastes 30, 1958.

Oxidation of Radioactive Glucose by Aerated Sludge. N. Porges, A. E. Wasserman, W. J. Hopkins and L. Jasewicz. Sewage and Industrial Wastes 30, 1958.



2. Whey Utilization

ARS-EU

Problem: The development of practical biological methods for the production of feed supplement, and other useful products from cheese whey.

Program: Applied laboratory research on the fermentation of whey to produce feed products, carried on at Philadelphia, involving 2 professional Federal man-years annually.

Progress: Conversion of whey to high protein yeast can be accomplished rapidly and in high yields. Yields of 50%, based on the solids present in whey, have been obtained in 4 hour propagations. Prior sterilization or heat treatment for removal of whey protein are unnecessary.

Plans: The process will be applied to 1,000 gallon batches at a local yeast-drying plant, using whey from local cheese factories.

Publications:

Current Studies on Disposal and Utilization of Whey. 8th Annual Pro. Pacific Northwest Indust. Waste Conf., Washington State College, 1957.

3. Spray Irrigation

ARS-EU

Problem: The determination of the effectiveness of spray irrigation as a method for the disposal of dairy plant wastes.

Program: Contract with University of Wisconsin. Duration 2.5 years.

Progress: Studies on the 6 cheese plants are being completed. Conclusions can not be definite at this time. Indications are that the organic matter added in the waste can be readily oxidized by the soil and plant cover; that considerable water can be sprayed depending upon the type of soil; that the water moves laterally in the soil as well as downward, especially in soils with shallow hard pan; that the fertilizer value of the waste is quite high if the irrigated area can be used for crops; and that the soils under study can take up considerable sodium ion, but harmful effects eventually occur.

Plans: The project is being concluded.

Publications:

Objectives and Procedures for the Study of Spray Irrigation of Dairy Wastes. G. J. Breska, P. R. Erickson, G. A. Rohlich, L. E. Engelbert and N. Porges. Pro. 12th Industrial Waste Conf., Purdue Un. 1957.



PROPOSALS FOR  
COMMITTEE CONSIDERATION

II. UTILIZATION RESEARCH

1. Dry Whole Milk

The development of dry whole milk that can be reconstituted to produce beverage milk is generally considered to be a promising way of making effective use of our surplus milk. Research upon this product, both basic chemical studies of the constituents of milk and product and process development, should be to accelerate the development of a satisfactory product.

A stable prime product of this type would rapidly gain wide acceptance in the U. S., supplementing the household milk supply and expanding over-all milk consumption. There are distinct long-range possibilities of developing an export market, thus broadening our outlets for milk and increasing markets. (1/8 and suggested by a Committee Member)

2. Concentrated Milks

New concentrated whole milk products, both sterile and non-sterile, which resemble fresh milk in flavor and texture when reconstituted, will meet a whole group of consumer needs and thereby expand markets for milk. Chemical studies of the effect of heat upon milk constituents, especially changes in gelation produced by processing and in storage, biochemical studies of the destruction of microorganisms and of the germination of spores, and process studies should be expanded to assist the development of such products.

The sterile processed milk products, despite rigorous quality control and careful plant operation, have been steadily losing their market in recent years. The consumer today requires high quality and fresh flavor in dairy products. Significant advances in knowledge and technology have been made but our present surpluses arise in large part from the decreased consumption of such products, a trend that must be reversed through research. (New-- suggested by a Committee member and an outside organization)

3. Butter and Butterfat

Improved butter and butterfat products will assist greatly in the economic marketing of butter to the consumer. Basic studies of the composition of butter and of its oxidative deterioration and process studies on new methods of producing and storing butter and butterfat should be expanded to assist the producer, processor, and consumer.



Despite the competition of oleomargarine and trends toward low-fat diets, one-fourth of the milk produced in the United States is still made into butter. CCC purchases of butter were over 215 million pounds in the last marketing year. Research on butter and butterfat is essential to a healthy dairy industry, especially in states removed from large fluid milk markets. (3/8--suggested by an outside organization)

4. Cheese

Maintenance of high quality and processing economies assist both the cheese maker and the consumer. Cheese research, including basic bacteriological and biochemical studies, the development of improved methods of making cheese, and economically sound processes for recovery of the values in whey, should be expanded to improve the consumer market for cheese and thereby decrease price-support purchases.

The consumption of cheese is rising in the United States, largely because of improved quality and marketing innovations. Yet Government purchases in the last marketing year totaled 250.8 million pounds at 35¢ a pound, or \$88 million. Both basic and applied research are needed to assist in eliminating this surplus. (6/8)

5. Effect of Detergents on Dairy Waste Disposal

Additional research is needed on the effect of new detergents on bacteria in the disposal field, and what this means in the requirement for acreage to handle sewage disposal. What is the efficient disposal system for dairy processing plants and its maintenance? Also suggest that results of previous research and the results of this research be published and the recommendations incorporated in one manual. (Suggested by an outside organization).

6. Decomposition of Cream

Cream of poor quality presents a real problem to the butter industry in their efforts to produce a good quality product. Research should be initiated on the decomposition of cream by the application of gas chromatography to the volatile constituents if deteriorated and/or low quality cream. (Suggested by an outside organization).

7. Phosphatase Test

The present procedures in applying the phosphatase tests to dairy products sometimes give inaccurate results. A comparative study should be initiated of the phosphatase which occasionally appears in pasturized-cream butter and that which is present in canned milk, for the purpose of devising a practical modification of the phosphatase test that would eliminate false positive results. (Suggested by an outside organization).



## 8.. Upgrading High Fiber Feedstuffs

Development of practical means of processing forages to up-grade their nutritional quality through elimination or modification of the poorly digestible fibrous components will lead to greater efficiency in the production of swine and ruminant animals. Alfalfa, grasses, and other materials utilized as forages, when mature, contain large amounts of fibrous materials made up mainly of cellulose and lignin that cannot be digested easily by ruminants. Research of both fundamental and applied nature should be initiated on the development of mechanical processes for fiber elimination or chemical or microbiological modification of the fibrous materials to improve their digestibility.

Livestock and forage production together constitute a major segment of the American economy today. In 1957 livestock accounted for 56.5% of all farm receipts. Beef cattle were in the vanguard of this economic return followed next by dairy products. During the same period harvested forages amounted to 121 million tons and nearly all of this production was used on the farm where it was produced. Nutritional and growth research studies have made great strides in increasing the feed efficiency of animals. Progress in obtaining high rates of feed efficiency particularly in ruminants has not been so spectacular. This work has been handicapped because it has not been feasible to feed low fiber feedstuffs in large quantity to beef and dairy cattle and sheep. In view of the continued per capita increased consumption of meat and dairy products and a steadily increasing total population, it behooves the livestock industry to increase the efficiency of production. This can be accomplished through improvement of feedstuffs used. Altering the fibrous nature of forages offers a very promising means for aiding this accomplishment.



### III. HOME ECONOMICS RESEARCH

#### 1. Amino Acid Requirements

ARS-HN

Problem: Tentative requirements for the individual "essential" amino acids have been determined for young men and young women, but similar information is needed for other typical age groups. Information is needed on the validity of these tentative requirements when fed as protein food in common mixed diets, with their different assortments and content of various essential and non-essential amino acids. Consideration should be given to the total nitrogen content of the diet and to other dietary factors affecting requirements and utilization of amino acids.

Program: Under contract arrangements, basic research is supported on requirements of young women for individual essential amino acids when fed in pure uncombined forms in semi-synthetic diets. Three contracts are under way to determine desirable patterns of amino acids intake in comparison with the assortments found in combined forms in typical food proteins, and to determine the availability of amino acids in foods as compared with chemically free forms. To a limited extent human studies are being paralleled with microbiological studies (2 professional Federal man years annually).

Progress: Findings on requirements of women for methionine and cystine (contract Un. of Wisconsin) have supplemented the information previously reported on the requirements of women for other amino acids. These studies have provided data on the metabolic response of women to a semi-purified diet containing various levels of methionine and cystine (cystine can replace methionine in part) and with 95% of the nitrogen furnished by purified amino acids and diammonium citrate. Under these conditions, on an intake of 290 mg. methionine with 10 mg. cystine or 300 mg. of sulfur-containing amino acids 3 of the 11 subjects stored nitrogen; the remaining 8 subjects lost from 0.01 to 1.19 gm. N. When the cystine level was increased to 260 mg., then 290 mg. methionine or a total of 550 mg. of the sulfur-containing amino acids appeared adequate with all the subjects investigated storing nitrogen. With a cystine intake of 500 mg., 4 out of 7 women stored nitrogen on methionine intakes of 150 to 180 mg.

Plans: Studies using human subjects will be continued in attempts to define the importance of various assortments of essential amino acids, and the dependence of nitrogen metabolism on the level and amounts of non-essential amino acids commonly found in food proteins. Studies with microorganisms will be continued to find more rapid, reliable methods for predicting availability of amino acids from foods.



Publications:

Nitrogen Balance of Women Maintained on Various Levels of Methionine and Eystine. May S. Reynolds, Dorothy L. Steel, Evelyn M. Jones and C. A. Bauman. J. of Nutr. 59, 99-111, 1958.

2. Fat in Nutrition

ARS--HN

Problem: The complicated nature of the problems of fat in nutrition has only recently begun to be appreciated. Better understanding of the role of fat in human nutrition is needed along many lines particularly with regard to the metabolic functions of certain fatty acids present in appreciable amounts in some of the fats normally consumed.

Program: Studies using laboratory animals fed different kinds and amounts of fat in diets characterized by excesses or deficiencies of other nutrients are being carried out for exploratory purposes, to develop criteria of fat metabolism, to describe short- and long-term physiological effects under intensified dietary conditions, and to give guidance to necessarily limited studies using human subjects. The studies with animals involve about 8 professional Federal man years. Human studies to date (three contracts) have been concerned with determining the effects of varying the levels of linoleic acid in dietary fat.

Progress: Research (contract Un. of Texas) continues to provide basic information important to understanding the role of linoleic acid. Dogs were used to develop a semi-micro method for determining distribution of fatty acids in blood. Data have shown a trend toward a higher level of serum fatty acids in female than in male dogs when the diet was low in fat (fat, 1%, and linoleic acid 0.1% of calories). No essential differences were observed between males and females in the fat levels or distribution of the unsaturated fatty acids in the sera of control dogs that were receiving 30% of the calories as fat with 5% of the calories as linoleic acid. Significant differences were observed between animals under one year of age and older animals in the amount of unsaturated fatty acids in the blood lipid fractions that were investigated. In the control group, the most outstanding effect of age was a significantly lower level for linoleic acid in the total lipid, phospholipid, and cholesterol ester fractions for the younger animals. In the fat-deficient group, linolenic as well as linoleic acid levels in the total lipid and phospholipid fraction were lower in the sera of the younger dogs. For both diet groups, a higher amount of glyceride fatty acid was observed in the sera of the younger animals.

Studies of tissue composition as affected by diet and age (rats) indicates that abnormal fat metabolism may result from deficiencies or from excesses of several nutrients. Data from the long-term



studies of aging rats have been summarized and a report is in preparation. Findings will affect design and control of experiments and criteria used for further studies. The age, timing, and sequence of appearance of disorders in various tissues as measured by chemical and histological means were found to be characteristic of specific diets.

Plans: Studies using rats will be initiated to define the relative importance of some of the nonfat dietary factors affecting fat metabolism. Additional analyses of blood lipids, mineral metabolism, and histological changes will be undertaken as new criteria of the effects of diet. In addition to the studies with animals, studies under contract in which young men receiving diets containing the same blend of fats modified to contain different levels of linoleic acid are being carried out at three locations. The feeding phase has been completed at two locations and analyses are under way.

Publications:

Effect of Fat in Diet on Unsaturated Fatty Acids in Phospholipid, Cholesterol Ester and Glyceride Fractions in the Serum of Dogs. Hilda F. Wiese, Arild E. Hansen, and Marjorie R. Baugham. J. of Nutr. 63, 623-538, 1957.

3. Multiple-Nutrient Studies of Human Metabolism

ARS-HN

Problem: Parallel analyses of many different nutrients as measures of metabolic response to diet should be undertaken to make full use of expensive metabolic materials and permit more adequate comparisons, evaluations, and interpretations of data for any one set of nutrients. Both scientific progress and research economy require multiple-nutrient analyses in studies of human metabolism wherever feasible, especially when common type diets of known composition are used.

Program: Three types of human metabolism studies are under way where multiple-nutrient analyses are arranged cooperatively or through contract to measure responses (a) to freely self-chosen diets; (b) to typical mixed diets of natural foods, (2 professional Federal man years); and (c) to a standardized reference diet of partially purified foods, designed for regulating intakes of specific nutrients and alternate substitution of food components (three contracts).

Progress: A standardized reference diet has been used in coordinated research (contract at Universities of Alabama, Nebraska, and Minnesota and Oklahoma State) to provide information on the range of individual variation in metabolic response of young women as an aid in interpreting nutritional data. Alabama reported a wide



variation both in urinary and fecal excretion for six subjects on a constant intake of calcium, phosphorus, and magnesium. However, for any one individual, a similarity was observed in the pattern of retention of those three minerals.

Oklahoma State studying 9 young women on the controlled reference diet with magnesium as the only variable found all to be in negative magnesium balance on 183 mg. daily intake of magnesium; the extent of loss varied with individuals from 3.2 to 80.6 mg. The highest level of magnesium investigated, 280 mg., was adequate for maintaining magnesium equilibrium in all 9 subjects.

In Southern Regional studies of the response to a mixed diet of natural foods by 8- to 9-year old girls, analyses have been completed on materials from studies initiated in 1954 and 1956 and reports are being prepared; collections from studies initiated in 1958 which represent diets of relatively low nitrogen content, were completed and analyses are under way. From the findings for studies of 1954 and 1956, it was observed that urinary pantothenic acid excretion differed considerably among subjects and in different locations. On the other hand, folic acid excretions varied over a narrow range and were fairly similar among individuals in normal states of health. Excretions of folic acid fell off sharply or ceased in the presence of infections such as colds, and of certain drug treatments. The digestibility of fat was very similar among individuals.

Reports from North Central Regional Cooperative studies of nutritional status on self-chosen diets deal with results of blood analyses. Data from 9-, 10-, and 11-year old public school children in Iowa, Kansas, and Ohio have been grouped by age, sex, and location and have been analyzed statistically. Major differences were observed in hemoglobin, ascorbic acid, and carotene values, which were significantly lower in Kansas than in Iowa or Ohio. No significant differences were observed among the states for the vitamin A values. Most of the children in Iowa and Ohio had hemoglobin values within the range generally considered desirable for this age group but only 39% of the children in Kansas had values falling within this range. Although the mean values for ascorbic acid, vitamin A, and carotene were high, the values for an appreciable number of the children in all states fell below the limits considered acceptable for these constituents. Serum alkaline phosphatase values, used in appraising calcium and vitamin D. nutriture, were obtained only in Iowa. A mean value of 5.42 nitrophenol units was obtained, with the values for 89% of the children in the range considered satisfactory.

Reports from Western Regional cooperative studies made in Northern New Mexico have indicated that a group of "Spanish American" boys and girls, 15 and 16 years of age, consumed diets containing less



milk, ascorbic acid-rich foods, and "animal" protein, than their "Anglo" classmates. These differences in dietary intake have been found to be reflected in some of the blood findings obtained with these children. Hemoglobin, volume of packed red cells, and red cell counts were significantly lower in the Spanish American group as were blood glucose, serum carotene, serum protein, and serum cholesterol. Serum ascorbic acid was generally low in all groups with over 50% of the subjects below the desirable level.

A report on the nutritional status of Montana 15-year olds and college freshmen includes a detailed analysis relating dietary findings with blood studies and physical findings. The blood studies have supported the results of the 7-day dietary records in several respects. Excellent or good blood values of vitamin A were observed for all of the 15-year olds and for most of the college freshmen, reflecting an abundant supply of this vitamin in the diets of all the subjects. In general, serum protein values paralleled protein intakes. Although ascorbic acid intakes and serum values correlated for some groups, exceptions were noted. For example, serum values of ascorbic acid were higher for females than for males whereas intakes were higher for males. Of riboflavin three-fourths of the girls and nearly all the boys had good to excellent intakes, but 90% were classified as having poor total serum riboflavin values.

Data obtained in the Western Region on the bone density values for approximately 2000 subjects 5 to 95 years of age provide a basis for the compilation of standard values for bone density of human beings. For all age and location groups studied, significant sex differences were apparent and basic differences in bone development patterns were indicated.

Plans: Analyses of materials from the third phase of the Southern Region cooperative project will be carried out during the year. Analytical data from the use of the reference diet with young women at four locations will be completed during the year and integration of data and evaluation of findings will be undertaken.

Publications:

Cooperative Nutritional Status Studies in the Western Region: II. Bone Densities. L. M. Odland, K. P. Warnick and N. C. Esselbaugh. Mont. Agr. Expt. Sta. Bul. 534, 1958.

Nutritional Status of Montana 15-year Olds and Montana College Freshmen. L. Guild and L. M. Odland, Mont. Agr. Expt. Sta. Bul. 536, 1958.

Nutritional Status of 9-, 10-, and 11-year Old Public School Children in Iowa, Kansas, and Ohio: II. Blood Findings. M. B. Patton, E. S. Eppright, and A. L. Marlett. Ohio Agr. Expt. Sta. Res. Bul. 794, 1957.



Variation in Mineral Metabolism Among Subjects Receiving a Constant Intake. Frieda Meyer. Ala. Acad. of Sci., Birmingham, April 1958.

The Magnesium Metabolism of Young Women. Ruth M. Leverton, Florence Waddill, and G. Odell, Amer. Insti. Nutr. Phila., Pa., April 1958.

4. Household Food Consumption

ARS-HHE

Problem: To obtain current information on food consumption and dietary levels, on related household practices, and on various socio-economic characteristics of different population groups, needed for research and education programs in nutrition and home economics and for economic analysis and development of programs in food production, marketing, and consumption.

Program: A continuing long-term program of food consumption studies, with nationwide surveys at intervals of 6-10 years, supplemented by smaller special-purpose studies (occasionally in cooperation with the States), and involving about 4 professional Federal man-years annually.

Progress: 1955 Food Consumption Survey. Data from the 1955 Household Food Consumption Survey are continuing to be widely used in numerous interpretive articles, charts, and speeches. Analytical studies of the data are also continuing. Tabulations required for studies of household food patterns as related to levels of selected nutrients and some other special analyses were completed. Publications are in process that show the relationship between food consumption and dietary levels and (a) size of the household, (b) age of the homemaker, (c) education of the homemaker, and (d) employment of the homemaker.

Plans include the completion of four additional reports in this series. Further progress will be made in the study and interpretation of statistical data obtained on (a) food patterns of households with high, medium, and low levels of consumption of important nutrients, (b) the relative advantages of alternative methods of measuring economic status of households as related to food consumption, (c) variability in the consumption of major foods and nutrients in households classified by region, urbanization, income, size and other characteristics, and (d) interrelationships during one week, in the consumption of selected foods, including an analysis of the food patterns of households with high, medium, and low consumption of various dairy products.

Diets of Selected Low-income Population Groups. Information on food consumption and food practices collected from 174 2-person and 109 1-person households receiving Old Age and Survivors Insurance benefits in Rochester, N.Y., has been edited and coded. Tabulations and nutritive value computations are in progress.



Plans include appraisal of the nutritive value of the diets of this low-income, older group of people and study of the relationship of their diets to various socio-economic characteristics and certain food habits and practices of the individuals in the survey. Analysis of the data on marketing practices will be carried out in cooperation with Cornell University.

Food Discards in Households. The study of the loss and discard of edible meat, poultry, and fish and fats and oils begun last year in a small town in Minnesota has been extended to include households in the St. Paul area and a beginning has been made in obtaining comparable data on losses or discards in grain products and in sugars and sweets.

Plans include continuation of the collection of data in St. Paul until a total of 50 or 60 households have participated and all food groups have been covered. Negotiations are under way for a similar study in California under contract with the U. of California at Los Angeles. If possible, the study will be extended to other areas. When enough data are collected, figures on losses for the various types of foods will be combined to obtain an estimate for the total diet, using the pattern from the 1955 survey as weights. It is hoped that more realistic estimates of the nutritive value of national and family food supplies can thereby be obtained.

Publications:

Food Production for Home Use by Households in the United States--by Region, Household Food Consumption Survey, 1955, Rpt. No. 12. Jan. 1958.

Home Baking by Households in the United States--by Region, Household Food Consumption Survey, 1955, No. 13. June 1958.

Home Freezing and Canning by Households in the United States. M. Orshansky and M. A. Moss, Family Econ. Review. Oct. 1957.

Home Baking. M. Orshansky, Family Econ. Review. March 1958.

Dietary Levels of Households in the United States, with Some City-Farm Comparisons. Corinne LeBovitz, Family Econ. Review. June 1958.

Trends in Family Diets. Faith Clark, Nutri. News, Vol. 20, Oct. 1957.

USDA Food Consumption Survey, Faith Clark, Natl. Dairy Council's An. Summer Conf., Chicago, Ill. July 1957.

Dietary Levels of Families in the United States. Faith Clark, J. Amer. Dietetic Asso., 34: 1958.



Family Diets in the South. Corinne LeBovit. Va. Dietetic Assoc. Conf., Richmond, Va. Nov. 1957.

How Well Do We Eat? Faith Clark. Amer. Home Econ. Asso. Conf., Philadelphia, Pa. June 1958.

5. Diet Appraisal

ARS-HHE

Problem: To evaluate the nutritional adequacy of diets of households and individuals and to develop research-based source materials for improving nutrition and food management through nationwide agricultural, educational, and health programs.

Program: An ongoing research program involving compilation and interpretation of research findings on nutrition and on food composition and the preparation of standard reference and educational source materials and involving about 12 professional Federal man-years annually.

Progress: Composition and Nutritive Value of Foods. The nutritional appraisal of foods and diets requires up-to-date figures on the composition and nutritive value of foods. A publication issued in Dec. 1957, includes tables that show amounts of 18 amino acids in 316 foods. Values are shown for the fluid milk of four different animal species and for 20 manufactured products. Data were compiled from world-wide scientific literature. The publication provides the most complete information now available for estimating the amino acid content of foods, dietaries and food supplies. It has recently been translated into Japanese.

Revised tables of average nutrient values are published periodically but the work of compiling, studying and summarizing data goes on continuously. Average values for Agriculture Handbook No. 8, now being revised, will take into account current practices in production, marketing and processing that affect nutritive value of foods, varieties of fruits and vegetables in greatest market production, current practices in trimming and packaging for the retail market, temperature and humidity control in transportation and storage of food, methods of processing, and preparation for eating. The revised tables will provide nutrient composition values for many more items than are shown in the present Handbook. Among the items being added are several products made from milk. The list of nutrients shown in the table is being expanded. In the food processing field, developments in frozen foods are among the most important, and there will be a greatly expanded list of frozen food items.

Plans: Revision and expansion of the food tables in Handbook No. 8 will be continued. Efforts are being concentrated first on the foods to appear in a condensed table of nutritive values being prepared for the 1959 Yrbk. of Agr.



Household Food Budgets. Family food budgets have been revised to keep pace with advancing nutritional knowledge and with changes in food habits and cost relationships as shown by the 1955 nationwide survey of food consumption and dietary habits. There are three food budgets or plans--a low-cost, a moderate-cost, and a liberal plan. Each plan gives suggested quantities of 11 groups of food for 18 age and sex groups and for women during pregnancy and lactation so that household or population totals may be obtained. One of the 11 groups is milk, including cheese and ice cream.

These food budgets have served for more than 25 years as a guide to help families achieve nutritionally adequate diets for the money they can afford for food. The food budgets have been widely used not only by families but by nutritionists, economists, teachers and welfare agencies, many of which base their money allotments for food for their clients on the low-cost food budget and use it as a guide in their counseling programs. Economists use the food plans as one help in estimating potential demand for agricultural products.

The estimates of the cost of food included in the food budgets are kept current by quarterly pricings using the retail food prices published by the U. S. Bureau of Labor Statistics. These estimates of cost are published in Family Economics Review.

Plans: A publication is planned to replace "Helping Families Plan Food Budgets," which will explain the development of the food plans, including the method used in their pricing.

Revision of several popular booklets will be completed.

Basic Data for Food and Nutrition Programs. A popular leaflet and wall chart have been published to supplement the publication "Essentials of an Adequate Diet" issued in 1956. In the first three months following its release nearly 150,000 copies of the popular leaflet were distributed. The Department gave extensive publicity to the new food guide, including press releases, TV spot announcements, radio and television interviews and a picture story for use by newspapers and magazines.

The leaflet and wall chart, both issued in 4 colors, appear to be meeting a demand for effective aids to nutrition teaching. The leaflet presents the 4 broad food groups--milk, meat, vegetable-fruit, and bread and cereals, with special qualifications regarding each--and tells how each group contributes to good nutrition, what foods are in each group, and the number of servings each day that will provide the foundation of an adequate diet.

Plans: The next publication in the series "Facts for Nutrition Programs" will deal with the relative economy of foods as sources of nutrients. A third publication on foods and calories is in progress.



Contribution to Nutrition Programs. A periodical prepared for members of State nutrition committees and other workers in nutrition education, was issued six times during 1957-58. Some of the issues contained factual information on programs or situations summarized for ready use as background for nutrition programs. One issue tells about trends in food consumption as shown by national food supplies and data from surveys of family food consumption.

Three issues were devoted to specific aspects of nutrition education. One issue high-lighted recent meetings of nutrition committees, forums and conferences. In observance of United Nations Day, another issue describes nutrition programs in Indonesia and Japan, two countries that have accomplished much of interest. Some of their nutrition programs and activities resemble our own. Others suggest ideas we might borrow.

Publications:

Family Food Budgets, Revised 1957. E. Cofer, Family Econ. Review, Oct. 1957.

Proceedings of Nutrition Education Conference, April 1-3, 1957, M. P. 745. Nov. 1957.

Essentials of an Adequate Diet, Revised. L. Page and E. F. Phipard, Home Econ. Res. Rept. No. 3, Nov. 1957.

Amino Acid Content of Foods. M. L. Orr and B. K. Watt, Home Econ. Res. Rept. No. 4. Dec. 1957.

Food for Fitness...A Daily Food Guide. Leaflet 424. March 1958.

Keeping the Values in Foods. B. K. Watt and H. K. Stiebeling, Today's Health, 36: April 1958.

Issues of Nutrition Committee News -

Training Programs for School Lunch Personnel. July-Aug. 1957.

Nutrition Programs in Indonesia and Japan. Sept.-Oct. 1957.

Nutrition Education Activities in Colleges. Nov.-Dec. 1957.

Meetings of Nutrition Committees. Jan.-Feb. 1958.

Present-day Concepts of Learning--Their Use in Nutrition Education for Elementary School Children. March-April 1958.

What's Happening to USA Food Consumption? May-June 1958.



PROPOSALS FOR  
COMMITTEE CONSIDERATION

1. Fat and Fatty Acids in Nutrition

The complex role of fats in nutrition and the serious nature of disturbed fat metabolism are now widely recognized, but much remains to be done to determine the processes involved in the utilization of specific fats or fatty acids. Research should be expanded to determine the metabolic response to different kinds and amounts of fat and various fatty acids as affected by other dietary components and by age.

Expanded research with laboratory animals in all stages of the life cycle is needed to define differential requirements for age and the long-term biological effects of various dietary stresses affecting metabolism of fat. In addition studies of fat metabolism in man on self-chosen diets and on controlled diets are needed to define the relative importance of the amounts and kinds of fat and assortments of fatty acids and also the relationships among various nutrients affecting the physiological utilization of fat. Research findings which will help to clarify the relation of dietary fat to the health and well being of human subjects will be of great importance to agriculture and the food industries as well as to public health. (1/15)

2. Factors Affecting Requirements for Protein and Amino Acids

Requirements of some age groups for amino acids have been determined using purified amino acids, but the application of these findings to requirements for food has not proven simple. Research should be initiated on factors affecting protein and amino acid requirements when fed as common foods in customary diets.

The research should involve laboratory animals for which appropriate tissue analysis as well as nitrogen balances can be carried out. It should also include human studies and development of improved research techniques to measure the course of nitrogen and amino acid utilization in the normal human organism. Factors in need of attention are the level of total nitrogen intake in relation to essential amino acid nitrogen, the patterns or assortments of essential amino acids, the supplementary action of various non-essential amino acids, and possible effect of non-nitrogenous nutrients on the utilization of protein. Consideration must be given to both antecedent and current diets, and also to the influence of age and physiological and nutritional state in altering requirements.



### 3. Yield and Quality of Combination Foods

Much uncertainty relating to the use of convenient combination foods and ready-to-use mixtures hinges around their unknown content. Analyses should be initiated to obtain basic data on physical or chemical composition of the most promising combination foods, fresh, frozen, canned, and dry, including information on yield and quality.

Requests are received to furnish information on: What are the probable impacts of such foods on the diets of families who use them most? How can their cost be compared to foods made from components procured in the usual form? How may one estimate the relative economy of ready-to-use foods? How much milk and other commodities do consumers get through these mixtures, and how should meals be planned making use of them? Occasionally samples are submitted by school lunch and marketing agencies for preliminary determination of yield and general quality. More recently from various sources have come questions on quality of canned and dry mixtures suitable for storage in defense shelters on a rotational basis in connection with in-plant or nearby food service units. Because of the likely role of such foods in the diets of children at home, school, and recreation, information should be available on their probable content of nutrients as well as on the component commodities. (New)

### 4. Improved Data on Consumption of Dairy Products

Statistics on the household consumption of dairy products and other foods are useful to producers, processors, and distributors in appraising market potentials and in making merchandising and management decisions as well as for appraisals of adequacy of diets and nutrition education programs. Research should be expanded to obtain data on the consumption of food both at home and away from home of family members of different sex, age, and occupation and on seasonal variations in consumption and also to improve techniques for data collection and analysis.

Some reasonably current data on diets of individuals are available but important gaps exist. Classes of individuals for whom there is relatively little information on their food consumption are men of all age groups and younger children. Household survey data (as from the 1955 survey) do not provide information on how the available food supply is shared by members nor do they usually obtain data on the quantity of each food eaten away from home. Systematic knowledge of the quantities of different kinds of foods eaten by individuals throughout the nation would provide a better basis than now exists for effective nutrition education, for the development of food budgets for persons of different ages, and for the forecasting of food needs and consumption patterns as the age distribution of the population changes.



National dietary surveys have usually been limited to one week in the spring because of interview problems. Some seasonal data on which interpretations for the urban population were based were provided in surveys made in 1948, but none are available for farm or rural non-farm families. It is expected that seasonal differences in the consumption of specific foods, in food expense, and in nutritive value of diets would be greater for farm than city families. However, questions about the seasonality of the food consumption of city families are frequently raised that can not be answered with existing analyses. (5/5)



#### IV. MARKETING RESEARCH

##### A. COSTS AND EFFICIENCY

###### 1. Impact of Bulk Milk Assembly on Market Structure and Practices AMS-MR-OC

Problem: To determine and appraise impacts on market structure and practices, including regulatory programs, resulting from shifts from can to bulk tank systems of cooling and assembling milk farm-to-plant.

Program: National surveys and case studies of changes in market structures, firm structures, milk marketing patterns and arrangements as related to the change from cans to bulk tanks in assembling milk farm-to-plant, involving 1.5 professional Federal man-years yearly, conducted at Washington, and to terminate in 1959.

Progress: A survey of approximately 60 Federal milk market administrators was made to determine changes associated with the introduction of bulk tank assembly in the overall market structure and milk marketing patterns in the markets they regulate. Arrangements were made with an industry cost accounting service to obtain quarterly reports relating to bulk, can, and dual receiving of milk for a sample of 80 fluid milk plants.

Plans: Analysis of survey data for Federal markets will be completed and a report prepared. Interviews will be made of a selected group of fluid milk plants to determine the effect of bulk tank assembly on individual fluid milk plants, their procurement and distribution programs and interplant milk movement. Quarterly data from the 80-plant sample will be analyzed to obtain information on changes in milk volume, product diversification and labor costs, as related to bulk handling.

###### Publications:

How Can Dairy Farmers Decide Whether to Use Tanks? D. B. Agnew, USDA, Agr. Sit., Vol. 41, No. 10, Oct. 1957.

Bulk Milk Tanks: Marketing Aspects. D. B. Agnew, Southern Regional Conf. Ext. Dairymen, Washington, D. C., Oct. 1957.

How Bulk Handling Affects Milk Plant Costs. D. B. Agnew, Milk Plant Monthly, Vol. 47, No. 5, May 1958.

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###### 2. Transportation Aspects of Bulk Milk Assembly in the Northeast AMS-MR-TF

Problem: To help avoid or solve difficulties encountered in the shift from can to bulk assembly of milk in regions typified by small and medium-sized dairy farms, through determining the advantages and disadvantages of bulk assembly in such a region.

\*Bulk Milk Assembly and the Revolution in Dairying. D. B. Agnew. 51st Annual Meet., Virginia State Dairymen's Assoc., Roanoke. Jan. 1958.



Program: The transportation aspect of this problem, running somewhat over three years, is being done primarily by the University of New Hampshire, under contract, based mainly on field interviews in northern New England, comparing bulk and can assembly as to transportation costs, transportation rates, operating practices of the trucking firms, and ownership of them (i.e., whether they are independent or whether the trucking is done by dealers or producers); and involves less than one professional Federal man-year per year.

Progress: USDA review of the proposed research bulletin has been completed.

Plans: Publication of the research bulletin will be by the University of New Hampshire and will complete the project.

3. Cost of Receiving Milk as Affected by Bulk Assembly

FCS

Problem: Producers and marketing concerns need reliable information on advantages, costs and problems associated with the shift from cans to bulk methods in handling milk.

Program: This problem has required analysis of receiving costs of an organization changing from can to bulk receiving, and for the last two years, data have been obtained under contract from a large midwestern cooperative for analysis at Washington, involving about one professional Federal man-year.

Progress: Preliminary review of the data indicates that receiving costs for plants undergoing the transition from can to bulk handling have increased. Receiving costs for strictly can receiving plants that are faced with a decrease in volume due to bulk conversion in the area have increased even more. Increased volume for a bulk plant has enabled its costs to be lowered substantially.

Plans: Work will be devoted to analysis of data and preparation of a report. Findings will be summarized in a published report and the project completed.

4. Methods, Equipment, and Facilities for Dairy Plants

AMS-MRD-ITB

Problem: Developing improved work methods, equipment, and facilities to increase the productivity of labor in dairy plants engaged in preparing for market fluid milk, evaporated milk, non-fat dry milk solids, butter, cheese, and ice cream; developing more adequate records and reports for dairy plants; and determining the possible effects of automation in dairy plants on future location, scale of operations, increases in efficiency, and quality of products produced.

Program: A five-year program involving accounting, economic, engineering, and technological research carried on in cooperation with the Indiana and Illinois Agr. Expt. Sta. at a rate of 1 professional Federal man-year annually.



Progress: Work is being conducted under four separate but related studies at two different locations. In Indiana, three studies are now under way covering: (a) improved work methods and equipment for ice cream plants, (b) more adequate records and reports for dairy plants, and (c) maximization of cheese and other dairy plant returns by determining the combinations of types and varieties of products that will most effectively utilize plant resources. In Illinois, a study is under way to determine the possible effects of automation and other advanced technology in dairy plants on their future size, location, and operational efficiency. None of these studies has progressed to the point that significant findings are available.

Plans: The above studies will be continued at the current scale of operations and it is contemplated that the study of automation in dairy plants will be completed.

Publications:

Fluid Milk Plants in the Southeast--Methods, Equipment, and Layout.  
J. C. Taylor and R. W. Brown. Market. Res. Rept. No. 232. Oct. 1958.

5. Dairy Department Operations in Retail Stores and Distribution  
Warehouses

AMS-MR-TF

Problem: Develop improved methods, operating practices, workplace arrangements, materials, and equipment for packaging and distributing dairy products in retail food stores and central warehouses to reduce costs and price spreads and to maximize sales volume in the interest of the trade and the producers and consumers of dairy products.

Program: This is about a 5-year program of operational-type research involving the determination of present successful practices and the development of improved procedures by the application of industrial engineering and management practices and principles to the retailing and warehousing of dairy products carried on in the facilities of cooperating firms located in various sections of the U. S., involving about 1 Federal professional man-year annually.

Progress: This work is still in its initial stages. Current work is concerned mainly with labor, materials and equipment requirements and costs for central market prepackaging of cheese. Standard data have been secured for packaging cheese in one retail outlet. A new method of displaying dairy products was developed and installed in a retail outlet and is being evaluated.

Plans: Present procedures in firms with the latest handling and packaging methods will continue to be studied. As soon as they are evaluated and improvements made, they will be installed in test stores where they will be further tested and improved.



6. New Containers for Milk and Milk Products

AMS-MR-TF

Problem: Climbing marketing costs of milk are of increasing concern to producers and consumers who would benefit by the development of new or improved packages that (a) are cheaper to buy, (b) require less expensive equipment, less power and less labor to fill and handle, (c) are lighter, more durable and easier to deliver, and (d) are more suitable and more convenient at point of sale and consumption.

Program: A three-year program of economic and engineering research to evaluate new or improved milk containers which offer maximum economy and convenience, initially in schools and later in other milk outlets, in cooperation with container manufacturers, and dairy plant operators and schools in New Jersey, Indiana, Louisiana, Mississippi and Missouri, and involving 1 professional Federal man-year annually.

Progress: Three case studies of new and conventional containers used in the school milk program have been completed. One study was made in a large plant, one in a medium and one in a small plant. The new containers were a tetrahedral half-pint paper package with an inner coating of polyethylene, and a five-gallon dispenser can. Although the can is not a new container, its use in schools is both new and uncommon.

In the small dairy, in-plant labor requirements for the automatically cased tetrahedral containers were lower than those for glass and conventional paper half-pints. In the medium plants, the same container without automatic casing required almost three times as much labor. In the large dairy, slightly more labor was required to wash, fill and handle dispenser cans as compared with packaging in conventional paper. Because of their re-use advantage, combined materials and labor cost of the cans was lower.

Because full cases of bottles and conventional paper containers were comparatively heavy, all schools required the driver to uncase the half-pint containers and set them out in the school refrigerator. The cases of 18 tetrahedral half-pints were very light and the schools accepted them without removal of the individual containers. The dispensers were 5-gal. units which could not be broken down. As a consequence, it required about 40% less time to deliver the tetrahedral half-pints and even less time for the cans; however, it required more labor within the schools to serve milk from the cans.

Plans: A report on the efficiency and suitability of new containers in the school milk program is in preparation. It is planned to extend the studies to other important outlets for milk.

7. Merchandising Fluid Milk in Multi-Quart Containers

FCS

Problem: The trend toward increased use of multi-quart containers tends to place milk plants that have not added facilities to handle such containers at a competitive disadvantage. Many milk distributors are faced with the problem of determining how their business is or may be affected by this development



Program: Work for the last two years has involved analysis of practices and costs involved in methods studies, with data collected nationally from 187 concerns; located in Washington; and involving about 1 professional Federal man-year.

Progress: A survey of cooperatives bottling milk showed that over 87% of all those reporting used some multi-quart containers. About 24% of the milk was packaged in multi-quart containers, mostly in .5 gal. The majority of the firms favored the .5 gal. container from a processing standpoint and three-fourths from a selling standpoint. It was the consensus that the only effective method of competing was to add a multi-quart operation. A few firms were convinced that twin-paks could compete successfully with multi-quart containers.

Nearly three-fourths of the managers of firms studied thought that per capita consumption of milk increased when milk in multi-quart containers was available to consumers. The two reasons given were (a) consumers have more milk on hand and, therefore, unconsciously use more, and (b) consumption increased primarily because of lower prices for milk in large containers.

Plans: Cost data will be analyzed and a report of the findings will be made. This project will be terminated at the end of this year.

Publications:

Ten Million Drink from Co-Op Milk Bottle. W. J. Monroe, News for Farmer Coop., June 1958.

8. Diversification of Dairy Production Facilities

FCS

Problem: Dairy manufacturing firms in the Midwest are concerned with the opportunities, costs and problems involved in handling Grade A fluid milk. Many of them feel a competitive pressure to add Grade A operations, but require a knowledge of market opportunities, and fuller knowledge of the experience of other organizations in deciding whether to expand into the Grade A field.

Program: Analysis of experience of dairy manufacturing associations in Iowa, Minnesota and Wisconsin that market fluid milk has been under way two years with data from 124 dairy manufacturing cooperatives in the three midwestern States being analyzed at Washington, and requiring 1 professional Federal man-year per year.

Progress: Preliminary analysis revealed that 65 out of 79 associations that handled Grade A milk predicted an uptrend in Grade A milk production in their supply area. Concerning adequacy of market outlets, the majority of them also felt that their association would be able to sell more Grade A milk, thus justifying increased production.

Over half of the cooperatives reporting were able to sell 80% or more of their Grade A butterfat in fluid outlets in Aug. and Nov., months of seasonally low production. However, in Febr., only about

one in four did this well, and in the flush production month of May, only one in five could report this high a utilization. During the four months analyzed, only two in five associations averaged 80% or more fluid use of Grade A milk. About a third sold between 40 and 80% in fluid markets, while the remaining cooperatives averaged less.

Plans: Reports on work under way will be completed and will analyze experience of dairy manufacturers in Iowa, Minnesota and Wisconsin with their Grade A sideline operations. A study will be made of how to decide within multi-plant concerns the specific uses to make of each plant.

#### 9. Variability in Producers' Butterfat Tests

AMS-MR-OC

Problem: Selection of the appropriate sampling procedure is a major factor in obtaining accurate and efficient butterfat testing and verification of producer tests.

Program: Eight Federal order markets and one unregulated market have furnished data on butterfat tests for individual producers' milk deliveries to 19 plants during about 90 plant months. About 1.5 professional man-years annually will be required to complete the above program.

Progress: These data have been analyzed to show the variability in individual producers' tests. Work continues to determine the effect on variability of weather, volume and variability of deliveries, level of test and other factors. A first draft of a report has been prepared covering the impact of certain sampling and testing procedures and the effect of methods of sampling and handling of samples on the variability of butterfat tests.

Plans: Upon completion of the present analyses and the projected reports, the project will be ended.

#### Publications:

Costs of Butterfat Sampling and Testing Programs. F. Stein, A. G. Mathis, and L. F. Herrmann, USDA, AMS, MRD, AMS-212, Oct. 1957.

More Money from More Tests. F. Stein, Agr. Market., USDA, AMS, Oct. 1957.

How to Figure Your Sampling Costs. F. Stein, Milk Plant Monthly, Vol. VLVI, No. 12, Dec. 1957.

#### 10. Costs and Efficiency in Distributing Fluid Milk

AMS-MR-OC

Problem: Current information on factors affecting efficiency in the distribution of fluid milk is needed to aid the dairy industry to adjust to changing conditions.



Program: Contractor furnishes periodic data on punched cards for a representative group of 80 fluid milk processing and distributing firms; about 1.5 Federal professional man-years annually are used to machine tabulate and analyze the periodic data for a quarterly publication and for comprehensive bulletins.

Progress: Four quarterly publications, giving primarily costs and margins, have been issued. These publications carried special analyses on allocation of the operating cost dollar, trends in labor cost and productivity, variations in net profits seasonally and among different sized firms, and growth of dairy firms. Important findings include: Delivery costs account for half of all labor costs; labor costs are increasing more rapidly than labor productivity; net profits per dollar of sales show wide variations seasonally but no significant variation between different sized firms; and dairy plants have grown by about 40% since 1952. A manuscript, incorporating comprehensive analysis of all data, is in process of revision.

Plans: The quarterly report will be continued. More comprehensive nonperiodic reports are planned in the coming year.

Publications:

Milk Distributors Sales and Costs. D. D. MacPherson and H. V. Smith, USDA, AMS, MRD, Quarterly: MDSC-3, April-June 1957, Nov. 1957; MDSC-4, July-Sept. 1957, Febr. 1958; MDSC-5, Oct-Dec. 1957, Apr. 1958; and MDSC-6, Jan.-Mar. 1958, July 1958.

11. Cost of Selling Milk Through Vending Machines

AMS-MR-OC

Problem: Information on costs involved in milk vending is needed as a guide to determine the feasibility of vending operations.

Program: The operations of milk vending routes and retail and wholesale routes in and around Martinsburg, West Virginia, were studied during the introduction of milk vending into that market.

Progress: A report was published showing the physical and monetary costs for vending milk in Martinsburg, on indoor, mixed, and outdoor vending machine routes and for retail and wholesale deliveries.

Plans: This project has been terminated.

Publications:

Costs of Distributing Milk Through Vending Machines and by Retail and Wholesale Routes, Martinsburg, West Virginia. J. E. Klein, AMS, MRR No. 229, May 1958.

Mechanical Milkmen Must Work to Pay. J. E. Klein, Agr. Market., June 1958.

12. Farm-to-Retail Spreads for Dairy Products

AMS-MR-OC

Problem: The widespread interest in the amount of the marketing margin for various dairy products, and in the factors influencing margins, necessitates information in this field.

Program: A continuing program of research is carried on to determine the prices received by farmers, the processing and distribution costs, and the prices paid by consumers for various dairy products, and about 3 professional man-years annually will be required.

Progress: In the Chicago market, over 70% of all fluid milk is sold in multiple-quart containers; single quart containers are of decreasing importance. On a per quart basis, sales in multiple-quart containers average considerably lower in price than sales in smaller containers. A manuscript has been prepared for a similar study of fluid milk margins and costs in the Akron, Ohio marketing area (coop. Ohio State University).

Retail prices for processed cheese ranged from 50 to 62 cents per lb. and marketing margins varied from 24 to 37 cents per lb. This range reflects wide differences in margins for comparable lots of processed cheese, both at the wholesale and retail levels. Farmers' share of the consumer dollar ranged from 40 to 54%. A comprehensive report of this study is being prepared (contract Univ. of Wisc.).

A report on marketing margins for butter was prepared. A manuscript on farm-to-retail margins for cheddar cheese produced in the South is being prepared for publication (contract Univ. of Tenn.).

A series of monthly retail prices for nonfat dry milk has been developed through cooperation with the Bureau of Labor Statistics. Information on marketing practices and costs is being assembled from secondary sources and from representative firms processing nonfat dry milk in consumer packages.

Preliminary steps have been undertaken and data collection has begun for a study of farm-to-retail margins for ice cream.

Plans: Reports on margins and costs for butter, cheddar cheese and processed cheese will be published during the year. Studies of fluid milk margins in other markets will be undertaken. Work on ice cream will continue. Work on nonfat dry milk margins is expected to be completed and a report ready for publication in the coming year.

Publications:

Farm-to-Retail Price Spreads for Fluid Milk in Chicago. L. F. Herrmann and L. F. Friend, MRR No. 246, June 1958.

The Price of Milk. Leaflet No. 409, rev. May 1958.

Marketing Costs and Margins for Fresh Milk. Misc. Pub. 733, rev. Sept. 1958.

Marketing Costs and Margins for Processed Cheese. J. K. Little and H. W. Halvorson, AMS-238. (Reprint. The Marketing and Transportation Situation, Apr. 1958)



Marketing Margins for Dairy Products. D. D. MacPherson and H. V. Smith, AMS-226, Febr. 1958. (Reprint The Marketing and Transportation Situation Jan. 1958.)

13. Relationship Between Weight and Volume of Milk and Cream

AMS-MR-OC

Problem: Processors of milk need accurate data on volume, weight relationships for calculating yields of dairy products and for converting volume to weight as in purchasing milk from farm bulk tanks.

Program: This project, in cooperation with Eastern Utilization, will require about 1 professional man-year annually to complete.

Progress: Determinations of the precise relationship between the weight and volume of milk at low temperatures have been completed, a report presented and an article is being prepared for publication. Findings with respect to the surface tension of milk, which came from earlier work on this project, have been prepared for publication. A number of determinations of the relationship between the weight and volume of cream have been made.

Plans: The work on cream is expected to be completed in Fiscal Year 1959.

Publications:

The Density of Milk at Low Temperatures. P. D. Watson, Mtg. Amer. Dairy Sci. Assoc., June 1958.

14. Effect of Dating Regulations on Costs of Milk Processing and Distribution

AMS-MR-OC

Problem: Some representatives of the dairy industry consider that State and city regulations requiring milk dating or coding lack public health significance and add excessively to costs of processing and distributing milk.

Program: A one-time Nationwide study of dating regulations and their effect has been under way since 1957, and about 1 professional man-year annually will be required to complete the program.

Progress: A National mail survey of city health officials has been completed and personal interviews have been made in a sample of retail stores in selected dating, coding and non-dating cities, to determine the effect of dating on availability of milk to consumers and on special deliveries and returns.

Plans: Data now collected will be analyzed, additional cost information obtained if necessary, and a report prepared. This project will be terminated after completion of the report.

15. Effect of Seasonality of Milk Supplies on Labor Costs in Dairy Plants

AMS-MR-OC

Problem: The seasonal fluctuation in receipts of milk at dairy plants prevents costs from being as low as they could be with uniform seasonal supplies. A measure of the amount of the increase in costs attributable to seasonality would be helpful to plant managers and others in deciding on measures to improve the seasonal pattern of receipts.

Program: The study is to be conducted under contract with Purdue University.

Progress: Negotiation of the contract has been virtually completed and work will begin when the contract has been signed.

Plans: It is planned to study the utilization of labor and factors affecting the recruiting of seasonal labor in a minimum of 6 dairy manufacturing plants for a 12-month period. Actual costs will be compared with a careful estimate of the cost that would be incurred by the same plants if they received the same total annual supply in equal monthly amounts.

16. Use of Proper Cost Records to Obtain Efficiency in Dairy Plants AMS-MR-OC

Problem: The lack of proper guides for developing adequate cost accounting has hindered the adoption of modern management methods, particularly in diversified dairy manufacturing plants.

Program: In cooperation with a State agr. exp. sta., to study the nature of operations in dairy plants in relation to the type of records maintained and the use of records to obtain efficient operations.

Progress: No work has been done on this project as yet.

Plans: Work will be initiated when cooperation, or a contract with an experiment station can be developed.

B. PRICES

1. Seasonal Pricing of Fluid Milk

FCS

Problem: Producer representatives and others need guidelines built on full understanding of pricing methods in order to select a seasonal price plan for their market and to adapt its specific provisions to the needs and conditions of the market. Similar information is needed with respect to selection and adaptation of other pricing provisions.

Program: Work for the last two years has involved analysis of provisions and results of seasonal pricing plans, work is done in Washington, using data from the entire U.S., and involves about 1 man year per year.

Progress: A reference report on all major types of seasonal pricing plans was completed, presenting basic provisions, advantages and limitations of various plans in use.



Much of the findings concern adapting rules and provisions of plans to local conditions. A strong point of base-excess plans is their clear logic in tying a producer's seasonal incentive to his own efforts. Base-excess plans were severely criticized in the late 1930's and discontinued in many markets. This was largely due to the rigidity and administrative problems of closed base plans, and these problems need not be repeated. The fall premium plan is market stabilizing, equitable, flexible in its provisions, and sufficiently definite to give farmers a sound basis for production planning.

Established producers under fall premium plans have strongly objected to new producers sharing payments from the premium fund. Seasonal variation of class prices is simplest and can be used courageously to provide a definite, substantial incentive, but often has not been so used.

Plans: A study of milk pooling plans will be made to analyze their basic provisions and results, and will make use of numerous technical and specialized studies of aspects of milk pooling.

Publications:

Seasonal Milk Pricing Plans. S. F. Krause, FCS Bul. 12, Oct. 1958

2. Marketing and Pricing of Surplus Milk

AMS-MR-OC

Problem: Proper pricing of surplus milk in fluid milk markets is important to the overall objectives of such markets and requires consideration of numerous factors.

Program: A comprehensive study of the factors influencing the marketing and pricing of surplus milk in the South Central area (Okla., Kans., Mo., and Ark.) is being continued, and involves about one professional man-year annually.

Progress: A report on market organization and structure for surplus milk has been completed. Important findings include the facts that cottage cheese and ice cream are preferred uses of surplus milk. These products are produced in most fluid milk plants. Milk excess to preferred uses is frequently handled at a loss by fluid milk plants. A manuscript is in preparation covering costs and margins of producing nonfat dry milk and butter in integrated plants.

Plans: The report on nonfat dry milk and butter will be completed. A study of costs of producing cottage cheese and ice cream in integrated plants will be undertaken. An overall report, bringing together the results of the separate studies to show their bearing on pricing of surplus milk, will be prepared.

Publications:

The Market for Class II Milk in Oklahoma, Kansas, and Western Missouri. D. D. MacPherson, MRR No. 263, Sept. 1958.

3. The Supply, Allocation and Pricing of Milk in Northeastern Markets

AMS-MR-OC

Problem: The excess of milk receipts over requirements for fluid purposes in some northeastern markets has caused serious pricing and marketing problems.

Program: A program of interstate study involving cooperation among States in northeastern U. S., through a technical committee, has been carried on since 1953, and involves less than one professional man-year annually.

Progress: A report was published on the receipts and uses of milk in Boston, New York, Washington, and Baltimore, giving information on receipts, seasonality, sources, shipments and utilization of milk, along with a description of the markets, including sanitary regulations and methods involved in arriving at prices. A second report dealing with the supply and surplus problems of small and medium size independent milk dealers in 4 northeastern States is in manuscript form. Analysis of quota plans has been completed and work is starting on a regional report.

Plans: This project will be terminated with the completion of the proposed publications.

Publications:

Plant Receipts and Uses of Milk in Four Leading Markets of the Northeastern States. A. D. Jeffrey, Cornell U., Agr. Expt. Sta., A. E. 1091, Northeast Reg. Pub. No. 36, April 1958.

4. Marketing of Class III Milk in the New York Milkshed

AMS-MR-OC

Problem: A more objective basis for pricing Class III milk in the New York-New Jersey market is needed to obtain a utilization of Class III that is in the interest of producers and results in efficient handling of this class of milk.

Program: Under a grant of funds from the New York Market Administrator, a comprehensive study of the marketing of products of Class III milk in the New York market, involving about 4 Federal professional man-years, was undertaken, to be completed in 1959.

Progress: Secondary data regarding Class III milk in the New York-New Jersey market and information obtained by survey from users of Class III milk have been analyzed. Drafts of 5 reports were prepared which give information on the organization of the manufactured dairy products industry, including location, types and size of plant, sources of supply, markets, costs, and pricing of products of Class III milk. Two other reports, being drafted, will analyze the decision-making processes followed in deciding on utilization of Class III milk and complete the analysis of the effect of changes in prices of Class III milk on its utilization in various products.

Plans: Reports will be completed for publication and the project terminated.



5. Operation of Classified Price Plans in Fluid Milk Markets

AMS-MR-OC

Problem: A firm basis is needed for resolving divergent views of producers, handlers, and consumers arising out of classified pricing.

Program: Basic research into the operations of classified pricing was carried on in Washington, required less than 1 professional man-year annually.

Progress: A report has been published, which evaluates and extends economic theory in the field of fluid milk pricing.

Plans: Completed.

Publications: Classified Pricing of Milk -- Some Theoretical Aspects. E. S. Harris, USDA, Tech. Bul. No. 1184, April 1958.

6. Allocation of Products Among Milk Classes

AMS-MR-OC

Problem: Developments in milk classification in Federal order markets indicate the direction and extent of changes that may be expected in solutions to pricing problems in fluid milk markets, and the basis upon which new milk products are likely to be classified.

Program: A one-time analysis was completed in Washington, of differences in the number of price classes and in the price class assigned to milk for specific uses, and the reasons for changes made in the classification systems of 68 Federal order milk markets over the period 1936 to 1958.

Progress: A report, in process of publication, indicates that economic situations and practices within Federal order markets have changed markedly in recent years, particularly since the end of World War II. Classification is increasingly emphasizing sanitary regulations and the form in which milk products move from the point of manufacture. The number of use classes has been reduced in markets generally, and the classification of milk for certain products has become more uniform. Further, study shows that practices with respect to the classification of new milk products are in general no different from those followed when established products are classified.

Plans: The project will be terminated with the publication of the report.

7. Reporting Butter Prices Received by Creameries

AMS-MR-OC

Problem: Information is needed to show the representativeness and relative accuracy of wholesale prices for bulk butter received by creameries, reported in different ways.

Program: Price information was collected from a sample of 38 Iowa creameries in fall and winter 1958, and analyzed in Washington.

Progress: Research was concluded and a report, now being reviewed, showed that average weekly net prices received by creameries can be reported using information from a sample of creameries, with accuracy within one-half cent of the true change in average price. Creamery-to-market transportation charges for bulk butter paid by most Iowa creameries tend to fall in a narrow range, 1.94 cents to 2.04 cents per pound to New York, and 0.71 cents to 1.10 cents to Chicago. Prices also could be reported with high accuracy, using either a group of selected creameries that could report prices immediately after sales, or from an estimate of prices based on creameries' agreements with wholesale receivers. Depending on the degree of accuracy required, a sample of 15 to 99 creameries would be required to report weekly average net prices, and a daily sample of 9 to 51 creameries for reporting a daily average net price.

Plans: The above report will be published and no further work is contemplated.

8. Impact of Retail Price Wars on the Dairy Industry and Consumers AMS-MR-OC

Problem: Knowledge of the impact of retail price wars on producers and consumers and their effect on the efficiency of operation of city milk markets is needed as a basis for producer organizations' and handlers' policy decisions and for regulatory and legislative action.

Program: Case studies will be made in approximately 12 retail milk markets where price wars occur, over a period of about 5 years, involving about 1 Federal professional man-year annually, with formal cooperation with experiment stations and other agencies as seems advisable.

Progress: This project has just been initiated.

Plans: A review of literature relating to retail price wars will be completed as a preliminary step. Field investigations will be carried on in city markets where retail price wars develop, as such price wars occur.

C. SUPPLY AND CONSUMPTION

1. Price, Supply and Consumption Analysis

AMS-AEc

Problem: A continuing flow of problems arise through the need to strengthen outlook work on dairy products, to analyze alternative agricultural policies and programs for dairy items and in general to provide statistical and analytical service to the public.

Program: Appropriate statistical methods are employed to establish quantitative relationships among the important series representative of changes within the dairy industry. These results are used as a basis to strengthen situation and outlook work generally, to present special analyses as the need arises, and on occasion, the statistical analyses are themselves disseminated for general use. Various series of data are supplied in answer to specific requests. Work on this project is conducted at Washington, and involves 1 professional man-year annually.



Progress: In the past few years primary emphasis has been given to the problem associated with the dairy surplus--contributions of changes from demand and supply sources, respectively--and to alternative proposals to remedy the problem.

The leveling of milk output in 1958, after several years of successive new records, apparently was the result of reduced red meat production and rises to unexpected levels in meat animal prices. The capitalized value of the average milk cow for strictly milk-producing purposes in 1958, deflated, dropped to the lowest levels since 1948, and helps much to explain the 3.5% decline in milk cow numbers. This suggests that the change in milk cow numbers for the immediate future is associated with the prospective cattle cycle and price pattern. The rate of production per cow promises to climb further upward each year, though this is being accomplished primarily by selecting animals of greater feed-using capacity--the relationship between milk produced and total feed used continues practically unchanged.

Plans: In the coming year, emphasis will be given to those factors that helped bring about a better balance between supply and demand for milk in order to anticipate more accurately if and when there may be a resumption of a large surplus.

Publications:

Six issues of The Dairy Situation, Nos. 262-267.

Statement on relationship between milk production and prices contained in Dairy Economics Handbook, Agr. Handbook No. 138, F.E.S., Dec. 1958.

Dairy Statistics, Stat. Bull. 218, Oct. 1957.

The Dairy Industry in Transition (three installments), Agr. Mktg., June, July and Aug. 1958.

Steady Demand for Milk Seems Assured in 1958, Agr. Situation, Dec. 1957.

Dairy Surplus Still a Tough Problem, Agr. Situation, July 1958.

Major Factors in Outlook for Dairy Products. Ann. meeting of Natl. Milk Prod. Fed., Nov. 1957.

2. Identification of Economic Factors That Affect the Production Price and Utilization of Milk and Measurement of Their Influence

Problem: Development of new statistical methods and application of existing methods for measuring economic factors affecting prices, supply and utilization of milk are undertaken to strengthen outlook work, to provide bases for analyses of alternative agricultural policies, and to assist research workers in making specific dairy analyses.

Program: A project of approximately 5 years duration involving basic research into the factors affecting prices, supply, and utilization of milk and the development of new statistical methods, carried on at Washington, and involving less than one professional man-year annually.

Progress: Research is being centered on several lines of investigation: (a) Measurement of economic influences that affect milk production within relatively short periods of time, such as a year, among States and regions as well as for the U. S., as a whole; (b) measurement of influences that affect long-range plans of farmers as reflected in the number of cows and replacement heifers they keep for milk; (c) analysis of factors that affect longer-run trends in production and utilization of milk; and (d) analysis of the effect of level of price support on supply and utilization of milk.

Work during the year has been confined primarily to measuring the effect of changes in current and past prices on the magnitude of adjustments made in number of cows and replacements kept for milk. Statistical analyses were run that were designed specially to delineate the extent adjustment in cow numbers would occur within relatively short periods of time, such as a year and the change expected providing farmers had time to fully adjust to the new price situation. For the short period, it was found that following a 10% change in price of milk, farmers tended to change number of cows kept for milk by about 2% in the same direction. Over a period of several years, if prices and costs remain the same as after the initial change, further adjustments would be made.

Plans: Research will emphasize the longer-run factors that affect production and utilization of milk. A preliminary draft of a technical bulletin reporting these research results will be prepared.

#### D. EVALUATION AND MAINTENANCE OF PRODUCT QUALITY

##### 1. Objective Measurement of Market Quality Factors

AMS-BS

Problem: New and improved techniques and devices for measuring quality factors that will provide better testing, inspection, grading, and standardization of agricultural commodities; that will indicate suitability for specific end uses; that will indicate physical and biological conditions that affect vulnerability to damage during storing, shipping, and marketing, are needed to improve and maintain quality of products in marketing channels.



Program: A continuing long-range research program comprising both basic and applied analytical, chemical and instrumentation studies in development of better testing and inspection procedures; conducted at Beltsville and elsewhere (contract Ia. State College), and involving about 2 professional Federal man-years annually.

Progress: Objective Quality Tests for Nonfat Dry Milk--An accurate ion-exchange method was developed for determining lactic acid in nonfat dry milk. Comparison of this method with the known Ling, Davidson, and Golden State methods showed that it was much more specific but slower. This specificity had no advantage for measuring sanitary quality, because all methods exhibited about the same degree of correlation with the direct microscopic count of nonfat dry milk.

A contract for research pertaining to the direct microscopic count of nonfat dry milk was successfully negotiated for the study of (a) the effect of raw skim milk quality and certain commercial processing practices on the direct microscopic clump count of nonfat dry milk; (b) development of new or improved techniques for making direct microscopic clump counts of nonfat dry milk. The first phase of this study involving collection and analyses of samples of milk at various points in the commercial processing of nonfat dry milk, is well under way. Six commercial drying plants at widely separated locations in Iowa have been visited. Four of these were high heat-spray process, while two were low heat-spray process operations. In addition, two roller process drying plants were visited. A total of twelve series of samples was obtained from these plants. Direct microscopic clump counts of all samples were made using the two standard stains, i.e. Norths' Aniline Oil Methylene Blue Stain and the Levowitz-Weber Stain. The distribution of the morphological types observed in each of the smears was also noted and recorded. Additional tests, not specifically called for in the contract, were also carried out on all samples.

Tests for Determining Baking Quality of Milk Solids--A satisfactory test has been developed which fills the dairy and baking industries' need for a rapid, reliable method of estimating both whey proteins and baking quality of nonfat dry milk. This simple spot-color test estimates quickly the amount of undenatured protein present. Samples of nonfat dry milk of good baking quality and low undenatured whey protein contents give pale spots, with characteristic diffuse edges. A comparison of results using this spot test on many samples of nonfat dry milk with actual baking tests on the same samples showed that this method will satisfactorily estimate baking quality. A technical paper describing the method was published.

Determining Dispersibility of Nonfat Dry Milk--The ease with which dry milk disperses in water is an important factor in evaluating its quality. A reliable objective method for determination of dispersibility and solubility of nonfat dry milk samples has been developed. It is faster than any method previously described, requiring only 10 minutes to perform and employs inexpensive apparatus. It readily differentiates various grades of powder as precisely as other methods. The test combines a mechanical method of determining dispersibility with a lactometer procedure for determining dissolved solids. A paper has been prepared for publication.



Plans: Research will be concerned with improving the direct microscopic count technique and to study the stainability of a random sampling of psychrophilic organisms isolated from raw milk and dry milk. The metabolism of growing bacteria will be studied in order to find better metabolic indicators of the sanitary condition of nonfat dry milk.

Publications:

An Improved Method for the Determination of Lactic Acid in Dried Nonfat Milk Samples. J. Velasco and C. R. Noll, Jr., Assoc. Off. Agric. Chem.; Nov. 1957.

Chemical Estimation of the Sanitary Quality of Nonfat Dry Milk. W. A. Moats, Amer. Dry Milk Inst., Madison, Wisc.; Nov. 1957.

Method for the Rapid Estimation of Undenatured Whey Proteins in Nonfat Dry Milk. W. A. Moats and L. Feinstein, Jour. of Dairy Sci., Vol. 41, No. 7; July 1958.

Testing Dry Milk for Bread Baking. Agr. Res., July 1958.

New Stains for Bacteria in Dry Milk. W. A. Moats, Amer. Dry Milk Inst., Univ. of Wisc., Madison, Wisc.; Oct. 1958.

A Study of the Relationship Between Lactic Acid Content and Direct Microscopic Clump Count for Bacteria in Dry Milk. J. Velasco and W. A. Moats, Amer. Dry Milk Inst., Univ. of Wisc., Madison, Wisc.; Oct. 1958.

2. Insects and Mites Attacking Dairy Products

AMS-MRD-BS

Problem: The prevention and control of insects and mites that infest nonfat dry milk and cheese in processing plants, transit, storage, and marketing channels, will prevent serious losses to industry.

Program: This is a continuing program of applied research involving laboratory evaluations of pesticides, tests conducted under actual commercial conditions, investigation of chemical residues, and evaluation and improvement of commercial containers to prevent insect infestation, carried on in cooperation with the Wisconsin Agr. Expt. Sta. and involving 2 professional Federal man-years annually.

Progress: Laboratory tests have been completed in which a large number of chemicals were evaluated for effectiveness against cheese mites. Lindane, Diazinon, and synergized pyrethrum were the most promising and will be tested in the next phase of the work. Three walk-in refrigerators have been installed and are now in operation at different temperatures to be used in these studies. The compounds will be tested for biological effectiveness and a thorough investigation will be made of residue in relation to method and location of application in preparation for later experimental work under commercial conditions.



Taste panels detected no off-flavor in dried milk stored in rooms of which the walls had been sprayed with Malathion, Diazinon, or Lindane. Chemical analyses revealed no malathion residue but Diazinon and Lindane vapors had migrated through the container walls and contaminated the milk. The test is being repeated with malathion for a longer storage period.

Preliminary tests were conducted with three insecticides applied as aerosols against insects in empty freight cars. None was very effective against insects behind the liners of cars and some insects survived all treatments when they were partially protected by debris such as would be present in a car not thoroughly cleaned.

Tests are in progress to determine the protection against insect infestations provided by polyethylene liners for bags of dry milk and by chemical treatments applied on the outer ply of multiwall bags. Observations are continuing on the biology of insects in dry-milk plants and on the evaluation of spray treatments to control the insects in plants.

Plans: The next year or two will be required to complete the studies now in progress and continue those only recently started, along the lines reported.

Publications:

Observations of the Effect of Packaging Temperature of Nonfat Dry Milk on Insects in the Containers. F. O. Marzke and R. J. Dicke, AMS-218, Nov. 1957.

3. Keeping Quality of Pasteurized Milk Offered for Sale in the Chicago Market

AMS-MR-BS

Problem: Determine the rate of deterioration of pasteurized milk as supplied to the Chicago market and the need for the regulations requiring sale to the consumer within 48 hours after pasteurization.

Program: A limited program extending through one warm and one cool season to determine the keeping quality of milk as measured by bacterial counts and flavor ratings, with milk obtained from several Chicago suppliers and held at 2 temperatures after pasteurization, the work was done at the Univ. of Ill. by grant of funds and involved less than one professional Federal man-year.

Progress: Samples of milk stored at 40°F showed substantially no increase in total bacteria, and only slight increase in coliform bacteria, in 4 days after pasteurization. From a flavor standpoint only 11% of the samples considered acceptable 2 days after pasteurization were considered unusable after 6 days storage at 40°F. Deterioration was closely related to holding temperature with total and coliform bacteria increasing much more rapidly at 50° than at 40°F. Even at 50°F neither bacterial count nor flavor score after 4 days storage indicated any justification for the requirement that continuously refrigerated milk be disposed of at retail within 48 hours of pasteurization. Somewhat lower initial and cumulative bacterial counts were found during the cool months (Nov. through Febr.) than during the warm months



(April to July), but there was no appreciable increase in bacteria during 4-day storage at 40°F in either season. When storage was at 50° the proportionate increase in bacterial count was slightly less during the warm months than during the cool months.

Plans: The phase of this work is completed.

## E. MARKET ORGANIZATION

### 1. Marketing Organization and Practices for Mellorine

AMS-MR-OC

Problem: Insight into the marketing of mellorine and its relation to the frozen dessert industry is essential for rapid and efficient market adjustment by the dairy industry.

Program: A one-time study covering the marketing and costs and regulations for mellorine in the U. S., was carried out under contract, by the Univ. of Kans., Bureau of Business Research.

Progress: Results of a mail survey of plants manufacturing mellorine were published. A case study in 7 markets of the marketing of frozen desserts using fat other than milk fat was completed and a report readied for publication. This report shows that once a manufacturer introduces mellorine into a market, others feel compelled to follow suit. Ice milk and low quality ice cream successfully compete with mellorine for customers who are price conscious when price differences are low or when advertising or other promotion established these products or their manufacturers' brand names. Large firms have an advantage in marketing through their ability to make concessions to retailers and to control large-scale outlets. Prices for ice cream tend to be 10-30 cents a half-gallon above prices for mellorine, but the highest price for mellorine sometimes was as low as the lowest price for ice cream. Prices, competition, and market strategy of frozen dessert manufacturers, rather than an insistent demand for the product, seem to be important factors in the sale of mellorine.

Plans: A report will be published and the project terminated.

#### Publications:

Production and Marketing Practices for Mellorine. MRR No. 212, Febr. 1958.

### 2. Adjustments in the Dairy Industry of the Great Plains States

AMS-MR-OC

Problem: Information is needed to aid adjustments to changes in technology and demand and develop a more efficient and stable Great Plains dairy industry.

Program: A program of research over several years, regarding changes in farmers' markets for milk and cream, characteristics of dairy product manufacturing plants, and costs of assembly, processing, and distribution is being carried out in the Plains States and Iowa, in cooperation with State Agr. Expt. Sta. as a regional study and requiring less than 1 professional man-year annually.



Progress: Analyses have been completed of a survey of farmers' marketing practices and the relation of marketing practices to quality and a report prepared showing dairy marketing practices and potentials in the Northern Plains States. A survey of dairy manufacturing plants has been started to obtain information on their operating characteristics.

Plans: Work under way will be completed and followed by a study of costs of assembly, processing, and distribution.

3. Marketing Surplus Milk in the North Central States

AMS-MR-OC

Problem: The relatively small and fluctuating volumes of surplus milk received in fluid milk markets create difficulty in handling it efficiently and marketing it to the advantage of producers.

Program: A one-time research project involving cooperation with the 12 North Central and the Kentucky Agricultural Expt. Sta., and involving less than 1 professional man-year annually.

Progress: Analysis of the exploratory survey of 100 markets has been completed. Case studies of surplus milk marketing in 16 markets have been finished, and the data are being analyzed in preparation for a regional report which will compare the ways of handling surplus milk.

Plans: The efficiency of various systems of handling surplus milk and the causes of changes in the volume of surplus milk in the markets studied will be analyzed.

4. Pooling Requirements in Fluid Milk Markets

AMS-MR-OC

Problem: The standards for producers and plants to participate in market-wide pools may have considerable impact on the supplies of milk in fluid milk markets.

Program: A basic research study on this problem, carried on in Washington, is covering the operation of pooling requirements under milk market regulations, with intensive analysis of the experience of selected Federal order markets, and involves less than 1 professional man-year annually.

Progress: No work has been done on this study in the past year.

Plans: It is expected that work will be resumed during the coming year and the project carried to completion in 1960.

5. Procurement Practices of South Dakota Dairy Plants

AMS-MR-OC

Problem: Research and information programs need to be directed more accurately toward facilitating managerial decisions.

Program: Procurement policies and managerial decisions by South Dakota firms are being studied under a contract with the S. Dak. Agr. Expt. Sta.

Progress: A survey of 70 South Dakota dairy plants has been completed and the results analyzed to show the character of competition among these plants for supplies of milk.

Plans: Comprehensive personal interviews will be made of managers, directors and other persons influencing plants' decisions in 8 South Dakota plants, and results analyzed in preparation for a report.

6. Adjustments to Changing Supply and Demand in the South AMS-MR-OC

Problem: The southern dairy industry needs information on changing supply and demand conditions to make rapid and efficient adjustments.

Program: Regional research in the South in cooperation with the Southern States agr. expt. sta. and involving 1 Federal professional man-year annually, has been under way for several years.

Progress: Collection of information for determination of supply and marketing areas in the Lower Mississippi Valley and Texas has been completed. A report on the consumption and demand for fluid milk and its substitute, by 1481 households in 12 southern cities, showed that 83% of fluid milk purchases were fresh whole milk; 12%, buttermilk; and 5%, skim and chocolate milk. Half of fluid milk purchases were obtained from stores; half from retail routes. Average weekly purchases by the 35% of households buying milk only from retail routes were larger than weekly purchases of households buying only from stores. Average weekly milk consumption was 9.27 quarts of fluid milk--7.92 quarts at home, 1.35 quarts away from home. White households averaged 10.49 quarts per week and colored households 7.12 quarts. About 15% of households used nonfat dry milk, and about two-thirds evaporated milk, for both drinking and cooking. Increases in prices of fresh whole milk resulted in larger percentage increases in the use of fluid milk substitutes, while increases in income were associated with a smaller percentage in their use.

Plans: Analysis of supply and movement information will be completed, a report made, and the project terminated or revised.

Publications:

Consumption and Demand of Fluid Milk and Fluid Milk Substitutes in the Urban South. F. L. Corty and J. C. Purcell. Southern Coop. Series Bul. No. 53, Miss. Agr. Expt. Sta., Oct. 1957.

7. Impact of Concentrated Milk on the Fluid Milk Market AMS-MR-OC

Problem: The milk industry needs information to prepare for rapid and efficient adjustment to the new and improved substitutes for fluid milk now being developed.

Program: Secondary data were collected and analyzed.

Progress: Results of the analysis were published.

Plans: This work has been ended.



Publications:

The Probable Impact of Concentrated Milk on the Fluid Milk Market.  
A. G. Mathis, MRR No. 208, Feb. 1958.

Concentrated Whole Milk is a Qualified Challenge. A. G. Mathis, Agri.  
Marketing, Vol. 3, No. 2, Feb. 1958.

8. Marketing Milk in Alaska

AMS-MR-OC

Problem: Alaskan consumers need information on the comparative cost advantages and status of milk supplies in various forms and from various sources.

Program: A onetime study is being made, in cooperation with the Alaska Agri. Expt. Sta. involving 1 Federal professional man-year annually, to obtain and aggregate information on the sources, processing and distribution of fluid milk and other dairy products.

Progress: A survey of major Alaskan markets was completed and a report on the sources and kinds of milk sold in various ways and their costs and retail prices, is being reviewed.

Plans: This project will be terminated upon publication of the report.

Publications:

Alaska - New Laboratory for Milk Marketing Research. J. E. Klein, Agri. Market., Vol. 3, No. 2, June 1958.

9. Supply and Marketing of Milk in Hawaii

AMS-MR-OC

Problem: Local supplies of milk are sufficient to meet only part of the needs of the Hawaiian Islands.

Program: A cooperative study with Hawaii Agri. Expt. Sta.

Progress: By agreement with the Hawaii Agri. Expt. Sta., AMS withdrew its participation in the study of milk marketing during the year. The work is being continued as a project of the Territory.

10. Advertising and Promotion Practices for Milk and Dairy Products in the West

AMS-MR-OC

Problem: Proved ways are needed to increase consumption of milk and dairy products to at least its former level.

Program: A study requiring one Federal professional man-year annually to analyze sales techniques of milk dealers in the western region was instituted in cooperation with the Western State agr. expt. sta.

Progress: Western States have obtained data from a survey of milk dealers in the region.

Plans: The data from the survey will be tabulated, summarized, and analyzed and a report prepared.



## F. MARKET DEVELOPMENT

### 1. Market Potentials, Consumer Preferences, Merchandising, and Distribution Programs

AMS-MR-MD

Problem: To assist in maintaining or expanding markets for agricultural products by developing economic information on expansion possibilities for existing products and market potentials for new or improved products; by determining household, institutional, or industrial consumer preferences for and attitudes towards products in the form in which they reach consumers; by evaluating merchandising techniques including measurement of product availability and movement in retail channels, observation and experimentation with new techniques, and study of the effects of advertising and other promotional programs on the demand for farm products; and to obtain and analyze original data relating to patterns and levels of demand for agricultural products by population groups as an assistance to the understanding and administration of public aid and distribution programs and as guides to producers and distributors of agricultural products in making marketing decisions.

Program: A continuing program of marketing research involving field studies and analyses on a National, regional, or local basis in cooperation with utilization researchers, agricultural producers' organizations, Land-Grant Colleges, retailers, and administrators of food distribution programs and involving about 8 professional man-years annually. In some studies, private contractors may be used to collect and tabulate the basic data.

Progress: Market Potential and Consumer Acceptance of Sour Cream--Market testing of the possibilities offered by a uniform cultured sour cream product of high quality for expanding the consumption of butter fat was completed in Des Moines, Ia. It appears feasible to expand sales of cultured sour cream if proper promotional and sales efforts are employed. An intensive promotional campaign was carried out during Aug. 1957. Sales during that month were 129% higher than during the same month in 1956. Sales of cultured sour cream were trending upward during the year prior to promotion and part of the increase may have been due to this trend. For 8 months after the promotional program, sales remained well above the trend line extended from the previous year. After the special promotional campaign, Des Moines homemakers were surveyed. Three in 5 said they had noticed 1 or more aspects of the promotion, and the "use pattern" of some respondents appeared to have been influenced by it. Three in 10 had purchased sour cream during the preceding year, but only about 1 in 10 used it as often as once a month. The 2 most popular uses for sour cream were in baked goods and in salads. A report on this phase of the research is planned for early 1959.

Work on cultured sour cream will be continued pertaining to a National survey of dairies to determine distribution patterns and practices. This will provide basic market information needed to assist in an effective evaluation of the market possibility for sour cream on an area and National basis.



Effect of Promotion and Market Potential for Cottage Cheese -- Preliminary analysis of a promotional campaign for cottage cheese in low-consuming areas in the Southeast and a high-consuming area in the Midwest during Febr. and March 1958, indicates a slight increase in cottage cheese sales associated with the promotional campaign. The work is cooperative with the Milk Industry Foundation, the American Dairy Assoc., and the Georgia Agr. Expt. Sta. It is concerned with the possibilities for expanding the market for cottage cheese in the South where its consumption rate is low, through increased availability, an improved high uniform quality product, and expanded sales efforts. Data are being collected on sales in test markets and, for comparative purposes, sales in high consuming test markets in the North Central area.

It is anticipated that this phase of the research on cottage cheese will be completed and a final report of findings published during the year.

Attitudes and Practices of In-Plant Food Facilities -- A study was made of the frequency with which manufacturing plants provide food facilities and vending machines for employees, management attitudes and practices related thereto, and the size of the food facility market in terms of dollars spent and quantities consumed. Preliminary reports have been received from the contractor who made the survey, and results will be published as soon as the data can be checked and interpretive reports prepared. In addition to reports on the market as a whole, there will be separate commodity reports for dairy products and a miscellaneous publication including food fats and oils. Publication of these reports will extend at least into the 1960 fiscal year. No further exploration of this market is contemplated.

Sales Effect and Consumer Attitudes Toward Milk Through Vending Machines -- In Berkeley County, W. Va., sales of fluid milk through coin-operated machines located in industrial plants, and school and office buildings accounted for 1.5% of total fluid milk sales. About two-thirds of the sales through vending machines were "plus" sales indicating that the introduction of such machines can expand the total market for milk. Of employees having access to the milk vending machines, 63% bought milk from the machines during working hours. Previous to installation of the machines, only 19% had brought milk in from the outside to drink during working hours.

This study has been completed and a manuscript prepared for publication. No further work of this nature is planned.

Effect of Home Use of Nonfat Dry Milk on Evaporated, Fluid, and Filled Milk -- Home use of dairy products by Chicago families was analyzed for the period July 1954 to June 1957 to determine whether the improved nonfat dry milk, introduced in late 1954, resulted in an increase in total consumption of dairy products or possibly was substituted for fluid, evaporated, or filled milk. Preliminary findings are that there was no appreciable substitution of dry milk for the older products among the families studied and that purchases of the dry product represented an increase in total milk consumption.

This work will be completed with the publication of a manuscript which



Effect of Coupons and "Special Offers" on Sales of Food Fats and Oils at Retail -- Use of coupons in the purchase of salad and cooking oils in Chicago was found to be limited to about one-fifth of the households and in the purchase of margarine and shortening coupons were used by about one-half of the households. For all 4 products, the families most likely to participate in coupon deals were those with incomes above \$3,000, larger families, higher educational level, and younger homemakers. A relatively small proportion of the families accounted for a disproportionately large share of the total number of coupons reported. Only in rare instances were coupons or "special offers" responsible for increased purchasing of margarine at the expense of butter. Normally, an increase in the share of the market for a specific brand of margarine occasioned by the offering of coupons was achieved at the expense of competing margarines rather than butter.

A report covering the results of this study will be issued. No further research is planned.

Use of Selected Merchandising Materials on the Home Delivery Route -- A study of the impact of and difference between selected merchandising materials--leaflets and recipe books--on sales of fluid milk, cottage cheese, and sour cream on home delivery routes was initiated in Sept. in the Cumberland, Md. area.

The Special Milk Program (Its Effect on Consumption in St. Louis and Los Angeles Schools) -- Average daily milk consumption per pupil more than doubled in high schools in St. Louis and Los Angeles public schools serving milk after introduction of the Special Milk Program in 1955. In elementary schools, daily consumption rose by 50% in St. Louis and by 68% in Los Angeles.

The Special Milk Program appeared to equalize the level of milk consumption among children from different income districts. The demand for milk in schools was considerably more elastic among children from low-income districts than among children from medium- or high-income areas. Availability of milk in schools also influenced consumption. Consumption increased more in elementary schools offering milk at noon and recess than in those schools offering milk at noontime only.

The Special Milk Program (Consumption in the Nation's Schools) -- In a National probability sample of 4,400 public elementary and secondary schools, in March 1957, 90% of the milk sold was in schools operating under the Special Milk Program. Daily consumption of milk per pupil in schools participating in the Special Milk Program was half again as large as the level of per capita consumption in other schools serving milk. Pupils paid an average of 3.1 cents per half-pint for milk in schools participating in the program, and 5.9 cents in other schools. The proportion of public elementary and secondary schools serving milk was highest in the Northeast and Southeast, and lowest in the Midwest. The total volume of milk sales was greatest in the Midwest, reflecting a larger number of schools, low average prices for milk, and high average daily consumption per pupil in schools serving milk.

A publication pertaining to the consumption of milk in schools will be available for distribution in late 1958.



The Special Milk Program (in Nonprofit Summer Camps for Children) -- A study was initiated in the summer of 1958 to evaluate milk consumption in nonprofit summer camps for children in the Northeast region. A probability sample of camps was selected from the States of Maine, Massachusetts, and New York.

Data were obtained by which the per capita intake of milk by age and sex of children could be measured in relation to computed price charged the camp for milk, frequency and times of service, size of serving unit, and availability of competing beverages. Other information pertaining to administration, operation of the milk service, and occupancy of the camp was ascertained.

An analysis is currently being made with a report anticipated in the early part of 1959.

Total Food Consumption in Schools (Survey of Food Receipts by Schools -- Food used in public elementary and secondary schools, both purchased and donated, over a 12-month period has been ascertained from a National probability sample of schools. Data were obtained from the schools by individual food items and included both value and quantities. Other information includes: Sources of supply by major commodities, method of purchasing, and proportion of funds allocated to different food groups. The collection of data relating to the quantities of food used in public schools and their value has been completed, and an analysis of the data is under way.

Analysis of Food Distribution Plans -- An economic evaluation of possible ways of increasing consumption of food among low-income families is being made by means of three different economic models or approaches, using data obtained in the household survey of 1955 and Census population and family-income data. Under the first model, the food intake of the low-income groups is raised by a food stamp plan to the \$2,000-\$2,999 average level or approximately to that of the low-cost diet. A multiple pricing system is constructed for increasing demand for fluid milk among low-income groups as a second model. An income supplement to stimulate increased food purchases among low-income families, based on the number of children as well as family income, is explored in the third approach to the problem. The purpose is to provide a critical understanding of the implications of such programs, a basis for deriving estimates of the number of people whose food intake might be increased, differential effects on the different food products, probable costs of the individual programs, feasibility of such programs, and possible benefits accruing to farmers and others. Major work on the analyses of food distribution plans has been completed and a manuscript is in preparation.

Consumer Purchase Data -- From April 1957 through March 1958 monthly data on household purchases, prices paid, and related information for fluid milk (whole and skim), nonfat dry milk solids, butter, and margarine were obtained from the National Consumer Panel maintained by the Market Research Corp. of America. Quarterly reports were issued carrying breakdowns of purchases of the enumerated dairy products by regions and type of retail sales outlet. The annual report covering a 6-month period each dairy marketing year related household purchases to family characteristics such as income, size of family, age and presence



of children, and occupation and education level of head of household, providing a marketing profile of the purchaser for specific dairy products. This work was financed jointly by A.D.A. and the Department. In April 1958, the contract was extended for a 3-month period, excluding data for margarine for this particular period. Consumer reporting of purchase data for dairy products will be terminated with the quarterly report covering April-June 1958.

Plans: Several new phases of work that may be initiated during the year include: (a) a study of "beverage consumption patterns" in which the total per capita intake by children drinking milk and all other beverages will be compared for children attending schools operating under the Special Milk Program and schools not under the program; (b) determination of the market demand and consumer acceptance for low fat dairy products; (c) trial commercialization research to provide information whether the new concentrated sweetened cream can fit into the existing relationships in the ice cream manufacturing industry; (d) consumer criteria for evaluating quality and flavor in frozen desserts; and (e) determining the sales effect of various space allocations in the dairy case in the retail supermarkets and deriving net returns related to space for the various products.

Publications:

Household Purchases of Fluid Milk, Nonfat Dry Milk, and Butter (Monthly).

Household Purchases of Fluid Milk, Nonfat Dry Milk, Butter and Margarine (Quarterly).

Household Purchases of Fluid Milk, Nonfat Dry Milk, Butter, Margarine by Family Characteristics, April-Sept. 1957.

Containers for Retailing Fresh Fluid Milk. R. L. Hawes, Agr. Mktg., Jan. 1958.

The Special Milk Program--Its Effect on Consumption in St. Louis and Los Angeles Schools. K. E. Anderson, MRR 209, Jan. 1958.

Des Moines Homemakers' Use of and Opinions About Cultured Sour Cream, by Margaret Weidenhamer before the Amer. Dairy Assoc. Conf., Chicago, Ill., Febr. 1958.

New Product Technology and Its Effects on the Marketing of Dairy Products, Paper by P. B. Dwoskin. 13th Ann. Midwest Milk Mktg. Conf., Ohio State Univ., March 1958.

The Household Market for Butter. R. L. Hawes, Agr. Mktg. June 1958.

Lunch Programs in U. S. Public Schools. K. E. Anderson, Agr. Mktg.

Participation of Schools and Pupils in School Lunch Programs in Elementary and Secondary Schools of the United States. K. E. Anderson, MRR 262, Aug. 1958.

Consumption of Food in Public Schools. W. S. Hoofnagle. Paper. Amer. Farm Econ. Assoc., Winnipeg, Canada, Aug. 1958.



PROPOSALS FOR  
COMMITTEE CONSIDERATION

1. Keeping Quality of Milk as Affected by New Work Methods

Industrial engineering research on new work methods, equipment and facilities for milk handling should be accompanied by a study of the effect of such new procedures on milk quality. Research should be initiated to determine the types and numbers of microorganisms found in milk handled by conventional and experimental methods, and the effect of such microflora on the keeping quality and consumer acceptability of fluid milk.

Economics in marketing agricultural commodities can sometimes be realized by modification of methods and modernization of equipment and facilities. Any study of such possible changes must be conducted with consideration for and determination of possible effects on product quality. (12/20)

2. Insects and Mites Attacking Dairy Products

Improved methods for preventing damage to dairy products by insects and mites would greatly facilitate the ability of industry to provide uncontaminated food products at a reduced cost of operation. Research on the prevention and control of insects and mites attacking dairy products should be expanded to give greater attention to the development of protective packaging for nonfat dry milk, the use of insecticides to control dermestid beetles in milk drying plants, and an evaluation of the potential uses of pesticides against cheese mites.

Dairy products comprise an important item in the diet of the entire population of the country. Prevention of contamination and damage is necessary during production, storage, and transportation, as well as in retail channels. In addition to the concern of industry, the problem is important in relation to protecting government stores of surplus commodities. The matter of insecticidal residues is a significant part of this research and would also receive adequate attention. (3/20)

3. Measuring the Marketing Quality of Nonfat Dry Milk and Other Products

Problems concerned with solubility, dehydration, keeping quality, and wholesomeness arise when milk is reduced to the dry state. Research should be expanded on the development of appropriate tests for the market quality of milk solids and other dairy products such as cottage cheese.

More research effort is needed in the quality evaluation of non-fat dry milk to provide improved tests of dispersability and bacterial condition. Emphasis of this work should be directed to development of rapid, simple methods suitable for use in official inspection (6/20)



4. Consumers' Criteria for Evaluating Quality and Flavor in Frozen Dairy Dessert

The wide variety of ingredients and formulas now existing in frozen dairy desserts increases the need for a knowledge of consumer criteria in their selection of these products. Research should be conducted among consumers to ascertain the factors which determine their reaction to these frozen dairy dessert products.

At one time, ice cream was about the only frozen dairy dessert available but many kinds are now on the market. This trend toward increasing numbers of frozen dairy desserts increases the need for information relative to consumers opinions and preferences about the products. This proposed research would be of interest and value to various agricultural groups as well as those active in the processing and distribution of frozen dairy desserts. (New)

5. Effects of Grading and Labeling on Sales of Cheese

Grade emblems for cheese may help build and maintain markets for this important dairy product. An investigation is needed to determine whether the total market for cheese can be expanded by grading and labeling in accordance with Federal standards.

At present, although there are 4 Federal grades, AA, A, B, and C for cheese, there is practically no cheese on the consumer market today bearing these grades. Price is not always a dependable guide nor an accurate measure of quality for cheese. Use of grade emblems may help build and maintain confidence in cheese items, which could in the long run mean more higher quality cheese on the market and thus maximize sales. (New)

6. Market Possibilities of Low-Fat Fluid Dairy Products and Consumer attitudes Toward These Products

The dairy industry needs guidance in determining its course of action relative to low-fat fluid products and how best to merchandise and promote these products based on consumers' opinions about them. It is proposed to initiate work to measure the market potential for and consumers' opinions of low-fat dairy products as a means of increasing the consumption of dairy products.

Specific information is needed on the production and distribution pattern of low-fat dairy products in the United States including the uniformity and pricing of low-fat fluid products within and between markets, availability outside the large metropolitan areas, and the extent, kind, and duration of promotional activities attendant to the introduction of these products.

This proposed research would also investigate consumers' opinions and preferences for the low-fat fluid products relative to their appeal as weight-reducing foods. Information would also be obtained on whether dairy products are considered separately by consumers in this problem area or in relation to other foods. (New - suggested by an outside organization)



7. Trial Commercialization of Concentrated Sweetened Cream

A newly developed concentrated sweetened cream offers considerable promise in reducing the cost of ice cream manufacture. Research should be initiated to determine the commercial feasibility of this product in the existing structure of the ice cream manufacturing industry.

Concentrated sweetened cream, a development of EURDD, ARS, offers possibilities through substantial saving in handling, shipping, and storage cost. Developmental research on this product has reached a point where knowledge as to the economic feasibility of this product in terms of its suitability for the ice cream market is needed. Since the ice cream market represents a growing market for butterfat, concentrated sweetened cream with its inherent cost saving features could have a considerable impact on the ice cream industry and could conceivably expand the use of butterfat by ice cream processors. (New)

8. Effect of Packaging on Ice Cream Sales

The ice cream industry needs guidance in selecting the type of container which will maximize sales of its products at the retail level. Research is needed to determine the effect on sales of ice cream in the cylinder versus the rectangular package and also the sales effect of packages varying in visibility.

Many firms carry several package types for merchandising ice cream; this has ramifications in cost and efficiency as well as sales. This problem is not confined to any locality or any particular size firm. The findings from this proposed research would be directly applicable to decisions of ice cream makers relative to packaging to maximize sales through consumer satisfaction and to increase the efficiency of filling operations. (New)

9. In-store Promotion of Fluid Milk Byproducts

Alternative methods of merchandising and promoting fluid milk byproducts should be evaluated to expand markets for dairy products. It is proposed to conduct research to determine the effect on sales of in-store promotion for fluid milk byproducts such as cottage cheese and sour cream by use of feature displays, point-of-sale material, and taste demonstrations.

Studies over the past few years have indicated success with promotional campaigns using newspapers, radio, T.V., and billboards. Work is now under way to determine the effect of merchandising materials for cottage cheese and sour cream on the home delivery route. The findings from this proposed research would guide producers and distributors in evaluating this alternative form of promotion. (New)



10. Sampling and Testing Dairy Products for Butterfat

Losses of butterfat are of great concern to dairy plants. Studies of the variability of butterfat percentages in production runs of dairy products should be initiated as a basis for more precise sampling methods.

Accurate accounting of fat intake and outgo is an important factor in controlling losses, and the sampling and testing of finished products is one source of the necessary records. Methods of sampling finished products have not been sufficiently studied with modern techniques for statistical quality control. Managers of dairy plants and officials of governmental regulatory bodies would be helped by such studies. (New)

11. Yield of American Cheese

Plant managers concerned with efficiency of operations, and milk market administrators who must verify the utilization of milk in plants under their jurisdiction are concerned with variations in the yield of cheese from given quantities of milk. Studies should be initiated to determine the quantities of cheese produced from measured quantities of milk.

A systematic investigation of cheese yields, using data from plants maintaining complete records, together with measurements and observations by qualified technicians, would provide more satisfactory information than is now available in published form. (New)

12. Price and Quality Characteristics of Butter

Prices of butter appear to be poorly correlated with butter grades, and this hampers efforts to improve butter quality. Studies should be initiated to develop a better understanding of relationships between butter quality and price.

Such studies would involve an evaluation of the quality characteristics of butter offered for sale at retail in several cities and the retail prices. The results should help the industry to meet the preferences and needs of consumers and industrial users. (New)

13. Movement of Butter into Retail Channels

Data on the flow of butter into retail channels are an important guide to butter receivers and wholesalers, and others who need to analyze the demand for butter. Studies should be initiated to determine the sources of variation in the movement of butter into retail channels with the object of making the data more useful. Such data are currently reported in 4 markets. (10/20)



14. Size and Flexibility in Dairy Plants

The dairy industry needs information on changes that are taking place in the diversity of operations in dairy plants. Studies should be undertaken to bring up to date the information on flexibility of operation of dairy plants.

Technological advances are responsible for continuing changes in the diversity of operations in dairy plants. A research report based on 1944 data is the most recent description available. Information about recent developments would be useful to firms considering changes in their operations, and to research workers studying current marketing problems, particularly market structure, facilities and methods. (New)

15. Product Losses in Filling Dairy Containers

The increasing quantities of products packaged in single plants make it necessary and advantageous to control container filling within ever smaller tolerances. Initiate studies of the effectiveness with which existing practices and devices control the weight or volume placed in milk and dairy products containers.

Accuracy of weights and measures was one of the earliest marketing problems, but it may be timely to reexamine the the practices and devices now in use. In particular, the recent development of statistical methods known as statistical quality control suggests the possibility of productive applications to dairy processes. (New)

16. Marketing the Higher-valued Products of Fluid Milk Market Surpluses

Cottage cheese, ice cream and some other products may be a source of wider margins for processors and higher returns to producers than butter, cheese and nonfat dry milk. Initiate research to analyze market outlets, costs and returns from utilizing the surpluses of fluid milk markets in the higher-valued dairy products.

Such products have a preferred position as outlets for operating and seasonal reserves. Studies of market outlets for these products, and costs of processing and distributing them may contribute to a more profitable utilization of the fluid milk surpluses. (New)

17. Marketing Channels for Ice Cream

Substantial changes are taking place in the ice cream industry in response to technological and economic developments, which offset in some degree the whole dairy industry. Studies should be made of changes in marketing channels for ice cream, including sources of materials as well as outlets used by manufacturers.

The structure and marketing practices of the ice cream industry have been the basis for proceedings by the Federal Trade Commission in recent years. These actions indicate a need for background



information on the changes taking place in the industry and some of their technological and economic causes. Such information would be a partial contribution to a description and analysis of the costs of providing the services of marketing ice cream. (New)

18. Automatic Vending of Ice Cream

Automatic vending is a market outlet of growing importance for ice cream. Research should be initiated on the costs of marketing ice cream through automatic vending machines.

Similar studies of milk vending machines were important in furthering the useful and successful application of this marketing device. (New)

19. Dairy Plant Records and Reports

More adequate records and reports in a number of dairy plants are providing a basis for increasing overall plant efficiency including the reduction, handling, processing, and delivery costs. Research should be expanded to accelerate the development of improved forms and procedures for keeping accurate, complete, and concise records and reports and for testing these forms and procedures in different types of plants of different scales of operation.

For many years records and reports in most of the estimated 7,000 dairy plants throughout the country have been developed manually at excessive cost. Furthermore, the records and reports kept in many plants are not adequate to provide the data on specific operations needed by management to make proper decisions for the greatest operating efficiency.

Therefore, improved forms and procedures should be developed.  
(16/20)

20. New Containers for Milk and Milk Products

Packaging and related costs contribute a large share to the expense of marketing milk. Research to evaluate new and improved containers that are cheaper and more efficient to fill and handle should be intensified and extended beyond its present scope in the School Milk Program to other important outlets. A reduction of but a fraction of a cent in the per package cost could result in the savings of many millions of dollars a year. Many new and untried packaging materials are now being developed. Their application to dairy products merits immediate investigation.

About four billion half pints of milk were served in the nation's schools last year. A container cost reduction of a quarter of a cent would reflect a saving of close to \$10,000,000 annually in the school programs alone. With total non-farm milk consumption 20 times that of the schools, potential overall savings are many times greater. (9/20)



21. Improving Effectiveness of Market Organizations for Serving Large-Scale Producers

Large-scale dairy farms, including cooperative milking associations have marketing advantages and problems that differ from those of smaller units. Unless marketing cooperatives can effectively serve larger producers, these producers may begin to deal directly with proprietary bottling plants to the disadvantage of smaller shippers. Research should be initiated to help marketing organizations provide services and make needed adjustments to serve large-scale producers.

This study should cover special marketing needs of such producers and the influence of large-scale farms on markets and community practices. Most regions have a few exceptionally large farms and their number is increasing. (New)

22. Improving Methods of Producer Organizations for Serving Mass Buyers

The trend toward large-scale merchandising organizations and adoption of mass buying methods by those organizations confront manufacturers and processors of dairy products with difficult problems in meeting needs of those buyers. Expand studies of marketing methods used by farmers through their own organizations and the effectiveness of these methods in serving needs of large-scale buyers of dairy products.

Research should include such needs as product uniformity, uniformity of packaging, and provision of point of sale merchandising materials. The relation of the size of operation or degree of coordination in selling activities to the provision of services required by mass buyers will be a major part of this analysis.

Studies will be used to guide cooperatives and other marketing organizations in the production areas in making necessary changes to meet needs of chain store buyers, national dairy distributing concerns and others. Selling methods of manufacturers and of independent milk bottling plants will be studied in relation to buying methods for these products. Selling methods of market milk producers also will be studied in relation to needs of milk distributing concerns. Studies will supplement findings of other work underway concerning the changing structure of dairy markets. (New)

23. Development of Budgeting Procedures for Small Dairy Plants to Improve Planning and Control

Few producers' dairy marketing concerns, except the very largest organizations, apply formally and systematically accepted industrial budgetary procedures -- budgeting of operating costs and returns, finances, and capital expenditures -- which would provide a valuable tool for planning and administrative control. Research should be initiated to adapt industrial budgeting procedures to needs of producers' dairy marketing concerns.



Purposes of various types of budgets, methods of preparation, and their uses in managerial advance planning and decision making should be analyzed. Budgeting procedures will be outlined to fit special needs of parts of the dairy industry where budgets are not in common use and to assist such management in better planning and cost reduction. This work will supplement and enable fuller use by industry of results of economic-engineering and other marketing studies. (16/20)

24. Effect of Iced Milk on Sales of Ice Cream

Iced milk production--increasing each year for the past 13 years--may be gaining at the expense of ice cream. Research is needed to determine whether iced milks replace ice cream at the retail level or expand total consumption.

Sharp gains have been registered for ice milk in States where sales of this soft ice milk product were recently permitted. For example, sharp gains for ice milk were registered from 1956 to 1957 in New Jersey, Pennsylvania, and North Carolina. Little is known about the effects of this expansion of ice milk and it is important that the industry be guided by research findings in this area. (Suggested by an outside organization)

25. New Containers for Butter

Packaging is responsible for a substantial part of the total marketing costs of butter and improved packaging might reduce costs as well as provide better quality to the ultimate consumer. Research should be initiated to (a) develop packages which are efficient to fill and suitable for handling, stacking and long-time storage; (b) develop liners or coatings which prevent loss of moisture, reduce oxidation and which are non-toxic; and (c) develop packages which provide maximum economy in the use of packaging materials. Research should also be initiated on consumer packaging of butter in order to evaluate new and presently used packages for costs, salability, maintenance of quality, and acceptability to consumers. (Suggested by 2 outside organizations)

26. Effect of Whipped Butter on Total Sales in the Market

All areas of possible market expansion should be explored in light of the declining consumption rate for butter. It is proposed to initiate research to test the impact of whipped butter on total sales of butter and competing items in the retail store.

Only limited quantities of whipped butter are offered consumers at present and this is confined mainly to large metropolitan areas. Many retail food stores in urban and rural areas do not stock this product. In view of the importance of butter to the dairy industry, a research evaluation of the market acceptance of whipped butter should be made to guide the industry. (Suggested by an outside organization)



27. Keeping Quality Tests for Butter

The movement of butter through commercial marketing channels may involve considerable periods of time so that the keeping quality of this product is of paramount importance. Research should be initiated to develop rapid and reliable objective tests to predict the keeping quality of butter.

The presently used holding tests for predicting keeping quality of butter are based on a subjective evaluation of a sample stored for either two or seven days under conditions favorable for spoilage. Wide variations exist in the procedure employed by various butter organizations and erroneous predictions are sometimes made. The development of reliable objective tests to predict the keeping quality of various types of butter in commercial channels would be of benefit to butter manufacturers, buyers, and official inspection agencies. (Suggested by an outside organization)

28. Consumer Awareness of and Effect on Sales of Milk with Oxidized Flavor

A serious problem facing producers, processors, and distributors of fluid milk is oxidized flavor of milk. To help the industry in meeting this problem, it is proposed to initiate research designed to test consumers' ability to detect oxidized flavor in milk and the effect this flavor may have on sales.

Oxidation in milk has been recognized by dairy technologists for many years. This problem is apparently not confined to any particular area of the country. It may be a depressing factor in maintaining and expanding markets. The purpose of this study would contribute to a more complete evaluation of what the oxidized flavor may mean to the industry. (Suggested by an outside organization)

29. Flavor of Milk

Develop a method whereby individual companies could determine the ability of employees to detect milk flavors and off-flavors, thus setting up their own flavor panels for the grading of incoming milk supplies and for the final product. (Suggested by an outside Organization)



V. MARKETING SERVICE AND EDUCATION WORK

A. Marketing Service of the Department

1. Dairy Statistics

AMS-AES

Problem: Provide more comprehensive statistics on production and utilization of milk; expand data available on consumption of milk and milk products, both per capita and in total and strengthen the Department's monthly reporting of fluid milk and cream prices.

Program: A continuing long-term program of providing basic estimates of production and disposition of milk, milk cow numbers, grains and roughage fed dairy cows, production of manufactured dairy products, prices received by farmers' for milk and cream sold from farms, prices to producers and at resale for milk sold for fluid use in major markets over the country, consumption of milk products in Northeastern States and other markets and other miscellaneous dairy statistics compiled in 41 field offices and Washington for all 48 States and the U. S. developed partly in co-operation with State Departments of Agriculture and other cooperating agencies.

Progress: No progress because of lack of funds.

2. Promotion of Dairy Cattle Exports to Latin America

FAS

During the past year, Latin American dairy cattle market development programs utilizing P. L. 480 currencies were continued. In Feb. 1958, a Program Agreement was signed with the Purebred Dairy Cattle Assoc., representative of the five major U. S. dairy cattle breeds, with the objective of expanding the overseas market for U. S. dairy cattle.

At the request of foreign breed associations, 11 dairy cattle specialists judged cattle at livestock shows, classified cattle, held informal meetings with local breeders, and generally promoted U. S. dairy cattle during the past year. These activities were conducted in Argentina, Colombia, Chile, Ecuador, and Peru.

Demonstration dairy cattle herds were established in Brazil, Ecuador, Peru, and Chile. These herds, established at college and artificial insemination centers, serve as actual examples of the high quality breeding stock available from the U. S.

Current year expenditures of foreign currencies amount to \$56,000. Planned activities call for continued dairy cattle specialists' visits to Latin America, establishment of two more demonstration herds in other areas in Peru, and continued translation of educational and promotional literature. The possibility of stationing a full-time industry representative in Colombia is also being investigated.

Planned expenditures of foreign currencies during next year amount to \$33,000.



3. Market Development Program in Medellin, Colombia

FAS

A market development project, limited to the Medellin area of Colombia, was initiated. This is an educational campaign, directed toward farm producers of milk, milk handlers, and dairy product processors, and is designed to show the profitability of providing safe, sanitary dairy products for local consumption. Through this project, the Dairy Society International (the U. S. industry Cooperator) is assisting in the development of the Medellin area market for dairy products. Milk, recombined from U. S. dairy products, will be used by the local milk plants to supply that part of the demand that will result from the promotional campaign project which cannot be met by the limited local production.

4. Rendering Marketing and Processing Assistance in Foreign Countries as an Aid to Development of Export Markets

FAS

Practical plant demonstrations of various uses of anhydrous milkfat and nonfat milk and milk drinks, buttermilk, yoghurt, cottage cheese, soft white cheese, and sterilized milk have been made in selected areas in Latin America and the Middle and Far East where market development potential exists. This work is being continued. It has resulted in small initial orders for U. S. anhydrous milkfat and nonfat dry milk. Assistance in the expansion of the school milk program into rural areas in Japan is continuing. This program has increased the sale of nonfat dry milk to Japan. Dairy products of U. S. origin were exhibited at international trade and food fairs in Spain, Turkey, Yugoslavia, and Brazil. At the last-named fair, a total of 205,000 samples of milk, ice cream, and cheese were distributed. An exhibit of U. S. dairy products and a sample distribution of about 300,000 items is planned for the forth-coming fair in New Delhi, India, this year.

5. A Market Development Project in Thailand

FAS

This project has been in operation for almost 2 years. Its objective is to promote the use of recombined U. S. dairy products. Samples obtained from a recombining plant recently constructed in Bangkok are utilized for controlled nutritional studies and for standard promotion distribution. Progress to date has been satisfactory and the project is proving to be a valuable factor in promoting the sale of U. S. dairy products in Thailand. One hundred thousand dollars has been programmed for this project through 1959. This will close it out. Two similar projects are materializing in Chile and there are good prospects for beginning one in Ecuador and in Colombia.

A project in dairy product utilization in four countries, Brazil, Burma, India, and Pakistan is about to be undertaken. A dairy industry cooperator has been obtained for the Brazil project.



The purpose of this project is to promote market development for U. S. dairy products by finding ways of utilizing milk products in and with foods that are widely consumed in the above countries. The results of this project are expected to increase the long-run sales of U. S. dairy products in the above countries where protein foods are expensive and/or not widely consumed.

A total of about \$500,000 in foreign currencies is available for this project.

6. International Commodity Analysis

FAS

Analysis of reports from agricultural attaches in more than 50 countries, conference reports, trade publications, and related material has been continued. Data concerning production of milk and dairy products, international trade in dairy products, price changes and trends, foreign government programs affecting consumption, trade, and prices of dairy products and related material have been analyzed and reported. During the past year for the first time, data on U. S. exports of dairy breeding cattle were assembled and published at 6-month intervals. Related service research providing information and guidance for administrative policy decisions was continued.

7. Foreign Competition

FAS

Publications relating to studies of foreign competition made in Australia and New Zealand were issued. Manuscripts on competition studies made in Holland and Denmark are in progress. A competition study on evaporated milk was made in the Republic of the Philippines, and a report is in progress. Competition studies involving major U. S. dairy competitors in Mexico, Cuba and Venezuela and major U. S. poultry competitors in Western Europe are planned for the coming year.

Publications

U. S. Dairy Breeding Cattle Inspected for Export. For. Agr. Circ. FS 10-57, Oct. 1957.

World Output of Dairy Products in Second Quarter 1957 Higher than Year Earlier. For. Agr. Circ. FD 11-57, Oct. 1957.

World Milk Production in 1957 Estimated at One Percent Above 1956. For. Agr. Circ. FD 12-57, Oct. 1957.

Australia's Dairy Industry - Competitive Aspects. For. Agr. Rept. FAS M-25, Nov. 1957.

New Zealand's Dairy Industry - Competitive Aspects. For. Agr. Rept. FAS M-26, Nov. 1957.

New Zealand Shipments to U. K. Stand Out in Pattern of World Butter and Cheese Trade. For. Agr. Circ. FD 13-57, Dec. 1957.



Turkey and Iran Potential Markets for U. S. Dairy Products. For. Agr. Circ. FD 14-57, Dec. 1957.

World Output of Dairy Products in Third Quarter 1957 Above a Year Earlier. For. Agr. Circ. FD 15-57, Dec. 1957.

Pattern of World Trade in Dry and Canned Milk, 1955 and 1956 with Indications for 1957. FD 1-58, March 1958.

U. S. Dairy Exports under Title I, Public Law 480, 1956 and 1957. For. Agr. Circ. FS 2-58, March 1958.

U. S. Exports of Dairy Breeding Cattle, July-December and Annual 1957. For. Agr. Circ. FD 3-58, March 1958.

World Output of Dairy Products, Fourth Quarter and Annual. For. Agr. Circ. FD 4-58, May 1958.

Per Capita Consumption of Dairy Products, 1955, 1956, and Indications for 1957. For. Agr. Circ. FS 5-58, Apr. 1958.

Milk Production and Utilization in Principal Producing Countries 1957. For. Agr. Circ. FD 6-58, June 1958.

World 1957 Butter Production Sets Postwar Record; Cheese at Alltime High. For. Agr. Circ. FD 7-58, July 1958.

World Output of Dairy Products, First Quarter, 1958. For. Agr. Circ. FD 8-58, July 1958.

1957 World Trade in Dairy Products Shows Moderate Gain Over 1956. For. Agr. Circ. FD 9-58, Aug. 1958.

Latin America Best Market for U. S. Dairy Breeding Cattle. For. Agr. Circ. FD 10-58, Sept. 1958.

U. S. Dairy Product Exports Down in 1957; Decline Continuing. For. Agr. Circ. FD 12-58, Oct. 1958.

#### PROPOSALS FOR COMMITTEE CONSIDERATION

##### 1. Milk Production and Utilization

Expand work to provide more comprehensive and more accurate estimates of production and utilization of milk produced on farms. Such a program would include monthly estimates of milk production for 13 States not currently making such estimates, as well as providing monthly estimates of number of milk cows on farms and production per cow by States. Data would be made available on production of milk for fluid and manufacturing use by States, number of farms with milk cows with some breakdown by size groupings. Additional detail on grain and concentrate and roughage rations being fed to milk cows would be possible.



Such a program embodies major changes in present procedure. Surveys in all States would have to be greatly expanded and samples redesigned to more accurately determine changes in cow numbers, farms with cows, production per cow, utilization of milk and rations fed to milk cows. Data on plant receipts of milk and cream now available will have to be improved to provide the type check data needed for more accuracy in the estimates, as well as make possible, estimates of milk production by use categories.

## 2. Consumption of Fluid Milk Products

Broaden present limited program of per capita consumption estimates of fluid milk products to provide data by States annually. Such a program would make possible a continuing series of annual estimates of consumption of whole milk, skim milk, milk drinks and cream on a product basis, both per capita and in total by States and possibly by markets in some areas as well as the U. S.

Expansion of the present work on tabulation and compilation of data on fluid milk products to include data now collected but not analyzed would provide a sample accounting for over two-thirds of the total annual sales of fluid milk and cream to the urban and rural nonfarm population. By use of sampling techniques or enumerative survey methods, data on sales would be made available for the other States.

## 3. Reporting of Fluid Milk and Cream Prices

Improve the present system of reporting fluid milk and cream prices monthly by a thorough study of current sources and methods by which the prices are reported. This would include an inquiry into the adequacy of prices reported currently and an examination of the prices at the market level to determine if the quotations are accurately reflecting changes in marketing practices. Such an inquiry would also assess current reports as to their accuracy and completeness in reflecting true prevailing prices to producers and consumers in each market. The analysis would also investigate the necessity of developing methods of reporting other than the voluntary reports presently used and improvements that are possible if new methods should be adopted.

Improvement in the reporting of fluid milk and cream prices have been made within the limits of the use of voluntary reporters. Continuing changes in the method of pricing milk to producers and in marketing practices for milk products, have greatly complicated the burden of monthly price reporting.

## B. Education

### 1. Marketing Educational Programs

FES

The marketing educational work encourages the use of research results and other marketing information by farmers and marketing firms in their business decisions and by consumers in their



purchase and use of farm products. Farmers are helped with decisions concerning when, where, and how to sell, including packaging, grading, quality, maintenance practices, and group action to provide necessary marketing services. Work with the firms marketing and processing farm products includes new handling and processing techniques, quality maintenance practices, methods of reducing operating costs, and other management problems of the firms. Consumers are provided a variety of types of marketing information. Extension workers are guided in their programs by the local groups with whom they work, emphasizing use of research results in the solution of problems considered important by these groups. This work is conducted by the State extension services on a matched fund basis.

Several States conduct management workshops for agricultural marketing firms. Such workshops and conferences are helpful in developing sound programs and long range policies. Educational work to help these firms in long range planning is one of the important functions of several of the State extension programs. FES is developing intensive training for State specialists in management and long range planning.

The retailing and wholesaling of food receives special attention in programs in 15 States, where specialized workers devote their major attention to work with these groups. In other States less intensive work is conducted with these firms. Major emphasis is placed on helping independent supermarkets, affiliated groups of independents and chain firms use research results in management decisions to improve operational efficiency. FES in cooperation with AMS research workers have provided intensive training to the State specialists doing this work. The result is strengthened State programs based on research results, increased demand for extension assistance, and increased use of research results by marketing firms.

Extension consumer marketing programs are in operation in 39 States, employing on a full-time basis around 115 persons. These programs provide consumers with information which will help them in the purchasing of food and in understanding the production and marketing system. Most of these programs are located in major urban areas and use mass media almost wholly. Particular emphasis has been given to developing a better understanding of consumers--their consumption patterns, motivations, and values in the purchasing of food and the reasons for their changes, as well as the most effective mass media in reaching consumers. This information provides a base for more effectively disseminating information and presenting it in a form which will motivate consumers in their buying. The information will also help producers and marketing firms in producing and marketing for consumption.

More specifically, the educational work in dairy marketing has been directed at problems of producers, processors, distributors, and consumers.



The information included outlook as a basis for guiding production adjustments; information on operational efficiency as a means of helping those responsible for managing dairy plants to improve the efficiency; information about care and use of milk and its different forms was provided consumers as well as participation in the special school milk program and June Dairy Month. The impact of bulk handling of milk has created a need for information to help producers make decisions and for others in the channels of marketing about such things as premiums, handling methods, and the point at which ownership changes.

Those responsible for the management of dairy plants have been assisted in analyzing their operational efficiency to locate weaknesses and develop means for correcting them. In one State an analysis of three receiving stations indicated that a consolidation would reduce operating costs by an estimated \$100,000 annually. Another plant was given assistance in plant layout and job analysis in which operating costs were reduced in excess of \$100 per week.

Advances in milk quality improvement have progressed to the point where, on the basis of bacteria and sediment, most of the milk supply is reasonably good, but now more emphasis is being placed on flavor improvement. Off-flavors can occur in the most sanitary milk. Statewide programs on improving and maintaining milk flavor at all stages of production and marketing have been developed.

Information has been provided on sanitary regulations with respect to the possibility of their being barriers to the free flow of milk to markets under more uniform health regulations. An analysis of the advantages and disadvantages of State milk control was made in a State that was considering new legislation. Information about the objectives and operation of Federal milk marketing orders was furnished in many marketing areas.

#### PROPOSAL FOR COMMITTEE CONSIDERATION

##### 1. Educational Work of The Cooperative Extension Service

The educational work of the Cooperative Extension Service is an essential link between research and the solution of marketing problems. We recommend increased development of this work to facilitate adoption of marketing research results, with special emphasis on work with the firms engaged in marketing and processing agricultural products.

##### C. Service Work by State Departments of Agriculture

AMS-SDA

Service programs to improve the marketing of dairy products were conducted by 25 states and 1 territory. These were: Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maine,



Massachusetts, Minnesota, Mississippi, Missouri, Montana, New Jersey, New York, North Carolina, North Dakota, Oklahoma, Pennsylvania, South Dakota, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming, and Alaska. During the past year 14 States conducted programs which included such activities as the avoidance of contamination and control of bacteria through stricter sanitation procedures and temperature control, the elimination of off flavors and off odors, improving the quality of butter and cheese by helping to identify the sources and correct the causes of contamination interfering with the development of desirable structure and flavor and also assisting in improving processing methods which not only improved the quality but frequently increased efficiency and lowered costs. These States were: Georgia, Indiana, Kansas, Louisiana, Massachusetts, Minnesota, Mississippi, Missouri, Montana, North Dakota, Oklahoma, Vermont, Wisconsin, and Wyoming.

Programs to expand market outlets were conducted in 12 States and 1 territory during the past year. These States were Georgia, Illinois, Indiana, Kansas, Maine, Minnesota, Mississippi, Missouri, Montana, New York, North Carolina, North Dakota, and the territory of Alaska. This work for the most part was coordinated with such A. D. A. promotions as June Dairy Month and was in cooperation with State ADA groups. The State Departments of Agriculture through their intimate contacts with distributors, retailers, restaurants, and news media, were able to add much to the effectiveness of the national dairy promotional campaigns at the local level.

State Departments of Agriculture conducted programs to promote the sale and consumption of fluid milk and develop a better public understanding of the National School Lunch Program and the Special Milk Program. Marketing specialists contacted schools, institutions and summer camps to inform them of the requirements for participation in these programs. Specialists set up exhibits at State Fairs, teachers' conventions, and other civic and professional meetings and also appeared on radio and TV programs to promote the consumption of milk and other dairy products. Assistance in improving marketing facilities and equipment was provided by Departments of Agriculture in Georgia, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Montana, North Dakota, Wisconsin, and Alaska. Assistance was provided in the reorganization, location, design, and financing of newer type dairy processing and manufacturing plants to replace inefficient units, and provided existing plants with problems of selecting and installing new equipment needed for more efficient operation.

During the year 12 States and the territory of Alaska engaged in collecting and disseminating basic data and better marketing information. These programs included basic data on a State or county basis concerning the production and marketing of dairy products. Marketing releases on such information as quantities available, utilization, surplus and deficit areas, and prices were issued periodically by Indiana, Louisiana, North Carolina, Minnesota, New York, and Wisconsin.



PROPOSALS FOR  
COMMITTEE CONSIDERATION

1. Service Work of State Departments of Agriculture

Expand service work conducted by State Departments of Agriculture, or other appropriate State agency, with emphasis on programs to:

- (a) Improve and maintain the quality of dairy products through development and adoption of better handling methods at all levels of distribution and the adoption of proper methods of grading and classifying milk, butter, cream, and cheese according to established standards.
- (b) Improve existing facilities and design and location of new facilities, such as country processing plants, and advise marketing agencies with respect to the kinds of handling equipment and methods best suited to their operations.
- (c) Widen market outlets and move seasonal surpluses by providing producers and marketing agencies with complete information on the location of surplus and deficit areas; and by providing promotional assistance.







